City of Issaquah
Shoreline Master Program Update
Shoreline Inventory and Characterization Report

Ecology Grant #G0800024
Task 3
Deliverable for Task 3.2
December 2008

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Cover Photo: Lower Issaquah Creek, Lake Sammamish State Park and the Lake Sammamish shoreline. (Source: Washington Department of Ecology, 2007)

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1.0 INTRODUCTION

1.1 Purpose

The City of Issaquah (City) is conducting a comprehensive Shoreline Master Program (SMP) update with the assistance of a grant administered by the Washington State Department of Ecology (Ecology) (SMA Grant No. G0800024). According to Substitute Senate Bill (SSB) 6012, passed by the 2003 Washington State Legislature, cities and counties are required to update their SMPs consistent with the state Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58 and its implementing guidelines, Washington Administrative Code (WAC) 173-26.

An early step in the comprehensive update process is an inventory and characterization of shoreline conditions. The inventory and characterization provide a basis for updating shoreline management goals, policies, and regulations and for identifying public access and shoreline restoration opportunities. The term 'shorelines' in this report refers to areas that meet the criteria for 'shorelines of the state' as defined by the SMA (Figure 1-1). In Issaquah, these shorelines are:

- Issaquah Creek
- East Fork Issaquah Creek
- Lake Sammamish

This report describes the initial results of the shoreline inventory and characterization, which was completed in accordance with Task 3.1 of the City's grant agreement with Ecology. It includes a general discussion of the ecosystem processes that influence the City's shorelines and provides a detailed accounting of the ecological functions and land use patterns along each shoreline segment or reach. Accompanying this report in Appendix A is a series of maps depicting shoreline features and conditions (see Table 2-2 for a list of maps in Appendix A).[1]

This report has been revised from the draft published in April 2008 based on comments from Ecology and the public (Grant Task 3.2). Based on the findings of this report, the City will prepare a draft recommendations report identifying specific actions for translating the inventory and characterization findings into proposed SMP policies, regulations, environment designations and restoration strategies. The City will also prepare a separate restoration plan to more fully describe restoration goals and opportunities.

1.2 Regulatory Overview

Washington's Shoreline Management Act was passed by the State Legislature in 1971 and adopted by the public in a referendum. The SMA was created in response to growing concerns

[1] This report includes both Figures and Maps. Figures are included in the body of the text. Maps are included in Appendix A.

about the effects of unplanned and unregulated development on the state's shoreline resources. A central goal of the SMA is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines[2]."

Ecology administers the Act, but gives primary permitting authority for shoreline development to local governments. Local governments are also charged with developing SMPs in accordance with the state Guidelines developed by Ecology. The Guidelines give local governments some discretion to adopt SMPs that reflect local circumstances and to develop other local regulatory and non-regulatory programs related to the goals of shoreline management as provided in the policy statements of RCW 90.58.020, WAC 173-26-176, and WAC 173-26-181.

The City of Issaquah adopted its first SMP in 1990[3]. Since then, significant areas along Lake Sammamish and north of Interstate-90 (I-90) have been annexed. These areas currently fall under the King County SMP even though they are within City limits. These areas will be included in the City's SMP once this update process is complete.

SMPs are required to have a system for classifying shoreline areas based on their biological and physical characteristics, their existing and planned land use patterns, and the goals of the community. This system of 'shoreline environment designations' (SED) groups areas that share similar characteristics so they can be managed in a uniform and consistent manner. In a regulatory context, shoreline environment designations function similarly to zoning overlays. That is, they do not change the underlying zoning or other applicable land use regulations, but provide an additional layer of policy and regulations that can be tailored to the designation. The City's current SMP designates each shoreline as one of four urban environments or one of two conservancy environments. The current shoreline environment designations are shown in Figure 1-2.

[2] RCW 90.58.020

[3] The City's shoreline regulations are codified in Title 18 (IMC 18.10.940 through 18.10.1050) of the Issaquah Municipal Code.

Figure 1-1 City of Issaquah Shorelines

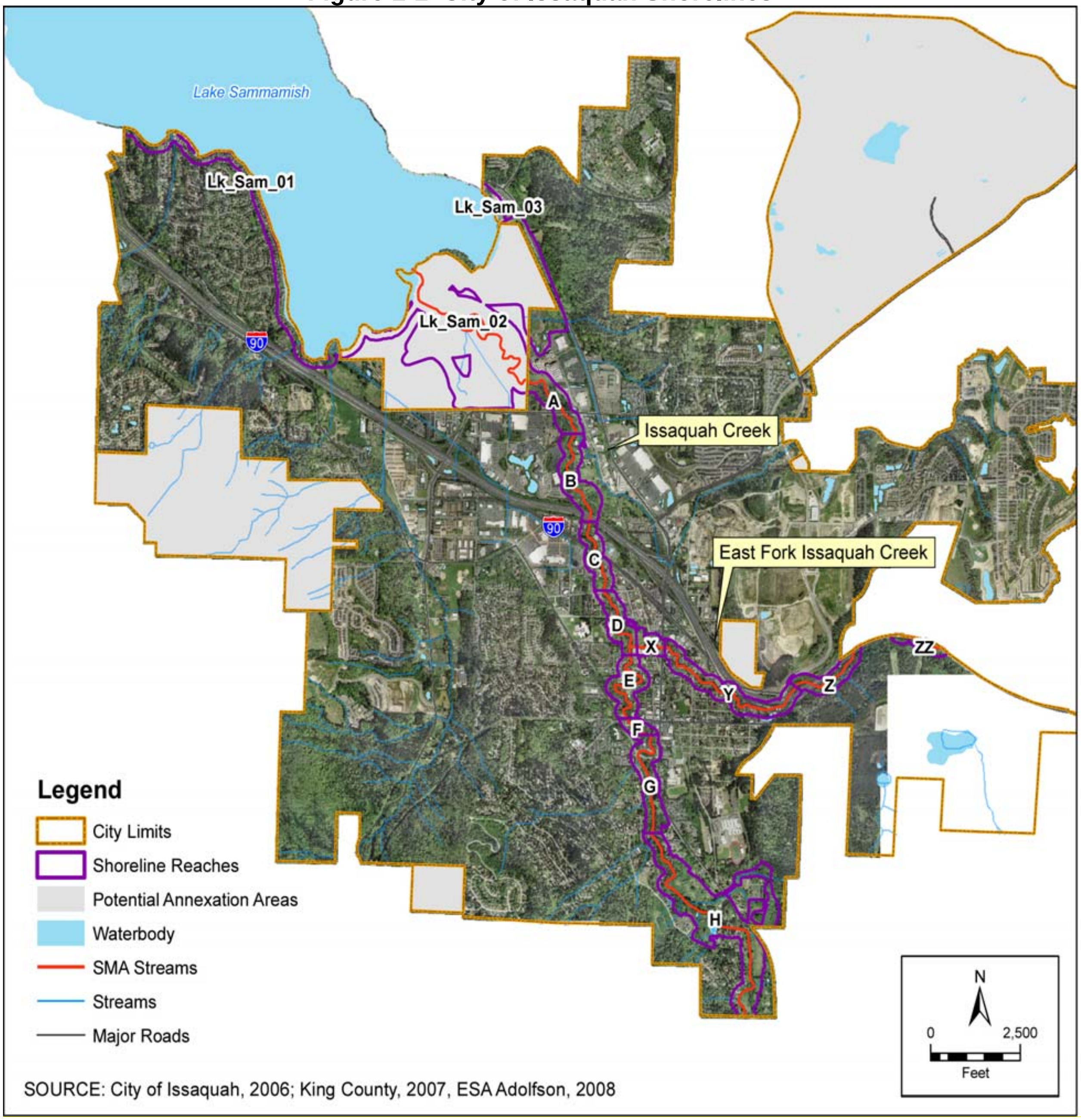
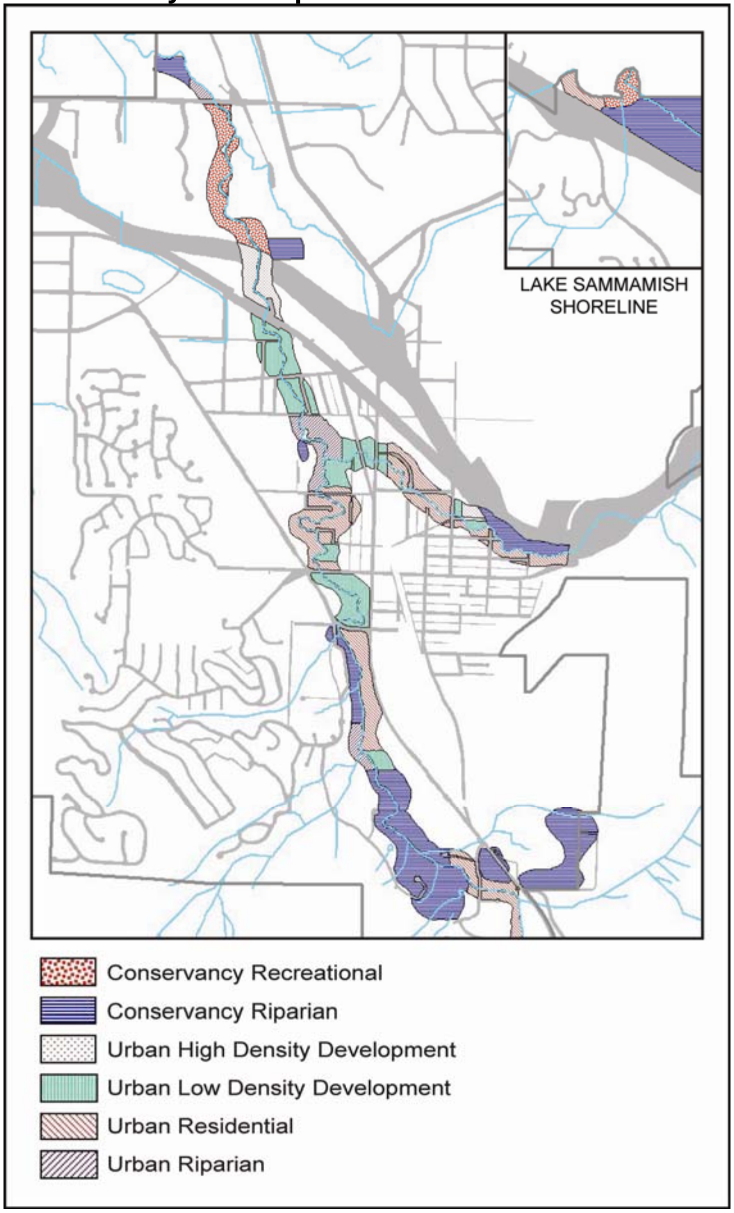


Figure 1-2 Current City of Issaquah Shoreline Environment Designations



Source: Parametrix, 2003

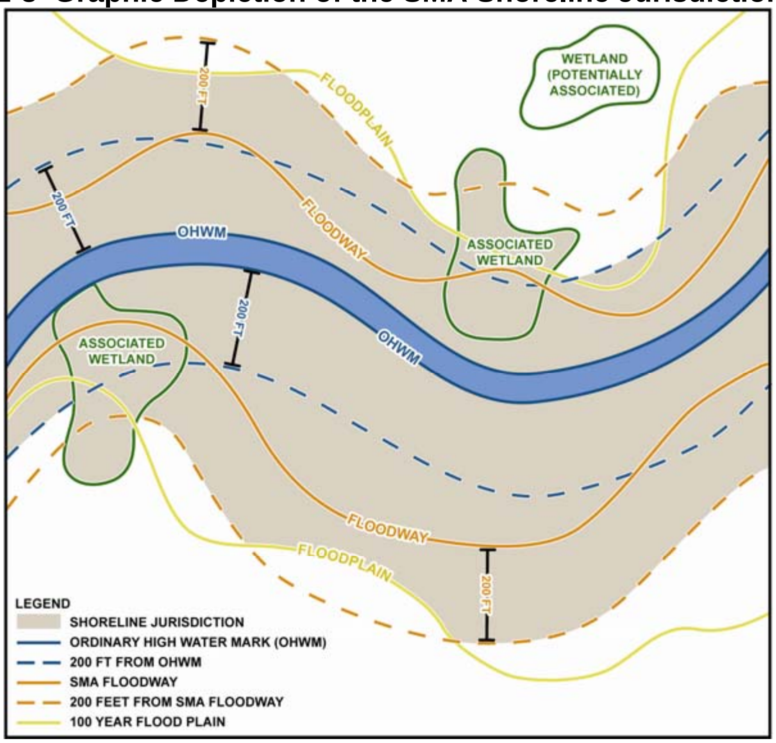
1.3 Shoreline Jurisdiction and Definitions

According to the SMA, the City's SMP regulations apply to all 'shorelines of statewide significance', 'shorelines', and their adjacent 'shorelands'[4]. Generally, 'shorelines of statewide significance' include portions of Puget Sound and other marine water bodies, rivers west of the Cascade Range that have a mean annual flow of 1,000 cubic feet per second (cfs) or greater, rivers east of the Cascade Range that have a mean annual flow of 200 cfs or greater, and freshwater lakes with a surface area of 1,000 acres or more. 'Shorelines' are defined as streams

[4] RCW 90.58.030

or rivers having a mean annual flow of 20 cfs or greater and lakes with a surface area of 20 acres or greater. 'Shorelands' are defined as the upland area within 200 feet of the ordinary high water mark (OHWM) of any shoreline or shoreline of statewide significance; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all associated wetlands and river deltas. 'Associated wetlands' means those wetlands that are in proximity to and either influence or are influenced by waters subject to the SMA (Figure 1-3)[5]. These are typically wetlands that physically extend into the shoreline jurisdiction, or wetlands that are functionally related to the shoreline jurisdiction through surface water connection and/or other factors.

Figure 1-3 Graphic Depiction of the SMA Shoreline Jurisdiction Limits



The City of Issaquah has identified six areas for potential annexation into the City. One of these Potential Annexation Areas (PAAs), Lake Sammamish State Park, includes the lowest reach of the Mainstem Issaquah Creek. If annexation occurs, this reach would become part of the incorporated area under the City's jurisdiction. At present, the Lake Sammamish PAA shoreline area is under King County's jurisdiction. This portion of the Mainstem Issaquah Creek shoreline is described in this report so that City policies and regulations can be developed to address this area in the event that annexation occurs before the City's next comprehensive SMP update. Map 1 (Appendix A) shows the approximate shoreline jurisdiction within the City and the extent of the reach scale maps.

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[5] WAC 173-22-030(1)

1.4 Relationship to other Plans and Programs

1.4.1 City Plans and Programs

The City's SMP works in concert with the Comprehensive Plan and a variety of other regulatory plans and programs to manage shoreline resources and regulate development near the shoreline. The Comprehensive Plan and associated Sub-Area Plans establish the general land use pattern and provide an overall vision for growth and development for areas inside and outside shoreline jurisdiction. Various sections of the Issaquah Municipal Code (IMC) also play a major role in how shorelines are managed. These include:

- **IMC 18.06 – Zoning**. Establishes zoning districts and regulates land use in the City including the shorelines.
- **IMC 18.10.010 -18.10.330 - SEPA**. Establishes city procedures and policies to implement the state environmental policy act (SEPA). All non-exempt City actions require environmental review under SEPA.
- **IMC 18.10.340 – 18.10.930 – Environmentally Critical Areas**. Establishes policies, regulations and land use controls to protect critical areas, including coal mines, streams, wetlands, steep slopes, aquifer recharge areas, as well as erosion, flooding, landslides, and seismic hazard areas consistent with the State's Growth Management Act (GMA). Additional information on critical areas regulations is provided in sections 4.1.1, 4.2.1, and 4.3.1.
- **IMC 13.28 – Stormwater Management**. Establishes policies and regulations for the comprehensive management of surface and stormwater, erosion control, and flooding.
- **IMC 16.26 – Clearing and Grading**. Regulates land alteration, particularly the clearing and grading of land in the City. Provides development regulations and construction procedures for ensuring that land clearing protects the natural qualities of lands and watercourses within the City.
- **IMC 16.27 - Tree Preservation**. Establishes regulations for the removal and/or alteration of trees in the City with the goals of retention, protection, and proper maintenance of specified trees.
- **IMC 16.30 – Erosion and Sediment Control**. Established regulations to control, limit and manage erosion and sedimentation, to protect and maintain the hydrologic balance of watersheds and watercourses, preserve wildlife and aquatic habitat and to protect the life and property of individuals. Requires preparation of an erosion and sediment control plan for all grading, filling, and excavation activities.

The SMA requires local governments and state agencies to review their plans, regulations, and ordinances that apply to areas adjacent to shoreline jurisdiction and modify those plans, regulations, and ordinances so they "achieve a consistent use policy" in conformance with the

Act and the SMP[6]. This means that the City's comprehensive plan and development regulations must be consistent with the SMP overall.

One of the most important areas for consistency is between the SMP and the City's development standards and use regulations for environmentally critical areas[7]. Environmentally critical areas including streams, wetlands, aquifer recharge areas, frequently flooded areas and geologic hazard areas are found throughout the City's shoreline jurisdiction. Although critical areas in shoreline jurisdiction are to be identified and designated under the GMA[8], they must also be protected under SMA. The Washington State Legislature and the Growth Management Hearings Board have determined that local governments must adopt SMPs that protect critical areas within shoreline jurisdiction at a level that is "at least equal" to the level of protection provided by the local critical areas ordinance for critical areas outside shoreline jurisdiction[9].

The GMA also calls for coordination and consistency of comprehensive plans among local jurisdictions. Because SMP goals and policies are an element of the local comprehensive plan, the requirement for internal and intergovernmental plan consistency may be satisfied by watershed-wide or regional planning. Consistent with this provision, the City of Issaquah is coordinating with King County and the neighboring cities of Bellevue and Sammamish during the SMP update process.

1.4.2 State and Federal Programs

As stated in WAC 173-27, it is the intent of the SMA to provide for integration of the shoreline permit into a consolidated environmental review and permit process. In achieving this goal, the shoreline policies and regulations contained in the updated SMP will also have to work in concert with several State and Federal permitting programs that relate to shorelines. These include:

- **Hydraulic Project Approval (HPA).** The HPA program applies to any construction activity in or near the waters of the state. The program is administered by the Washington State Department of Fish and Wildlife (WDFW). All applicable projects are required to submit permit applications to show that construction is done in a manner to prevent damage to the state's fish, and shellfish, and their habitats.

- **Phase II Stormwater Permitting**. The City is regulated under the Washington State Department of Ecology's Western Washington Phase II Municipal Stormwater Permit (Permit). This permit contains various requirements for stormwater management and operations that must be implemented over the 5-year permit ending February 15, 2012.

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[6] RCW 90.58.340

[7] IMC 18.10.340 through 18.10.930

[8] RCW 36.70A

[9] ESHB 1933

The Permit broadly applies to many City activities that involve maintenance and operations of City facilities, permitting of new development, inspections and enforcement of water quality regulations, and other activities. The City will be adapting codes, policies, and procedures as needed to comply with the Permit.

To meet the conditions of the Permit, a Stormwater Management Program (SWMP) has been prepared. The SWMP outlines all requirements of the Permit and a summary of the City's work program to meet those requirements over the 5-year permit term, and will be updated annually to incorporate progress on implementing the SWMP and changes to projected future work efforts.

- **Clean Water Act Section 404 Dredge and Fill Requirements**. Section 404 of the Federal Clean Water Act (USC 1394) regulates the discharge of dredged or fill material into waters of the United States. Any project that proposes discharging dredged or fill material into the waters of the United States, including special aquatic sites such as wetlands (non-isolated), must get a Section 404 permit. The U.S. Army Corps of Engineers (Corps) can authorize activities by a standard individual permit, letter-of-permission, nationwide permit, or regional permit. The Corps makes the determination on what type of permit is needed.

- **Clean Water Act Section 401 Water Quality Certification**. Applicants receiving a section 404 permit from the U.S. Army Corp of Engineers, a Coast Guard permit or license from the Federal Energy Regulatory Commission (FERC), are required to obtain a section 401 water quality certification from the Department of Ecology (Ecology). Issuance of a certification means that Ecology anticipates that the applicant's project will comply with state water quality standards and other aquatic resource protection requirements under Ecology's authority.

- **Washington State Water Pollution Control Act**. All projects effecting surface waters in the state, including those that are not subject to the Federal Clean Water Act sections 404/401 must still comply with the provisions of the State's Water Pollution Control Act (RCW 90.48).

- **Federal Endangered Species Act (ESA)**. All projects that have the potential to directly or indirectly impact wildlife species listed as endangered or threatened under ESA are subject to environmental review by the U.S. Fish and Wildlife Service (USFWS) or the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries). Chinook salmon in Lake Sammamish and Issaquah Creek are listed as threatened.

- **Army Corps of Engineers Section 10 (Permit for Work in Navigable Waters)**. The Corps has jurisdiction in all navigable waters of the State, including Lake Sammamish. Any work in, over, or under navigable waters of the U.S must apply for a Section 10 permit. The purpose of Section 10 permitting is to prohibit the obstruction or alteration of navigable waters of the U.S. The Corps has also issued Regional General Permit – 3 (RGP-3), to authorize new or modification of existing residential overwater structures in Lake Washington, Lake Union, and Lake Sammamish provided they comply with a set of standards. Docks that do not comply with the RGP-3 standards may still be permitted by the Corps, but would have to be permitted through the standard Section 10 procedures.

2.0 METHODS

2.1 Determining Shoreline Planning Area Boundaries

The approximate extent of shoreline jurisdiction within the municipal limits of the City of Issaquah and its designated PAA is shown in Figure 1-1 (and Map 1 of Appendix A) and referred to as the 'shoreline planning area.' In general this extent represents:

- Lands within 200 feet of the mapped edges of Lake Sammamish within the City's municipal limits;
- Lands within 200 feet of the mapped edges of Lake Sammamish within the designated PAA of the City;
- Lands within 200 feet of the mapped edges of Mainstem Issaquah Creek and the East Fork Issaquah Creek;
- All floodways associated with the areas above;
- Those portions of the 100-year floodplains currently mapped by the Federal Emergency Management Agency (FEMA) that are within 200 feet of the mapped floodway; and
- All mapped wetlands that lie adjacent and contiguous to the areas above.

This area covers a total of approximately 12 linear miles within the City limits and two miles within the Lake Sammamish State Park PAA. Of those, approximately six miles are along the Mainstem Issaquah Creek, four miles are along the East Fork Issaquah Creek, and two miles are along Lake Sammamish within the City limits. The shoreline planning area encompasses approximately 719 acres, of which approximately 278 acres (39 percent) is located in Lake Sammamish State Park.

Planning area boundaries were derived using existing GIS information[10]. For purposes of this report, the mapped edges of the lake and creek shorelines are assumed to correspond to the approximate location of the OHWM, but field inspection is required to identify the actual OHWM location on a specific property and determine jurisdiction limits, regulatory setbacks and/or buffers. Likewise, the mapped wetlands may or may not be 'associated' wetlands; generally a wetland's relationship to the shoreline must be determined in the field by on-site inspection[11].

The shoreline planning area is intended for planning purposes only. As a result, the actual regulated boundaries of shoreline jurisdiction may differ from the area shown on Map 1 depending on information gathered on the ground at any specific location.

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[10] ESA Adolfson reviewed the latest USGS data regarding upstream boundaries for SMA streams and rivers (USGS, Water-Resources Investigations Report 96-4208) as well as summary data provided by Ecology (available at http://www.ecy.wa.gov/programs/sea/sma/st_guide/jurisdiction/SMA%20Suggested%20Coordinates.xls) to confirm SMP jurisdictional boundaries.

[11] Additional associated wetlands may be present that are not depicted on the available maps.

For purposes of the shoreline inventory and characterization, the shoreline planning area was divided into segments, called reaches. For Mainstem Issaquah Creek and East Fork Issaquah Creek the reaches defined in the 2003 Stream Inventory were used. An additional reach (ZZ) was added to the east end of the East Fork based on review of the latest USGS data regarding upstream boundaries for SMA streams and rivers (USGS, Water Resources Investigation report 96-4208). Lake Sammamish was divided into three reaches. The middle Lake Sammamish Reach (Lk_Sam02) also contains the portion of the mainstem Issaquah Creek (and associated wetlands) that is within Lake Sammamish State Park. The extent and general description of the individual shoreline reaches that comprise the City's shoreline planning area are summarized in Table 2-1. The reaches are also shown in Figure 2-1.

Table 2-1 Shoreline Planning Reaches

Shoreline	Reach Numbers	General Description	Approximate Size (acres)[12]	Approximate Percentage of City's SPA (excluding PAA)
Mainstem Issaquah Creek	A through H	Stretches from Lake Sammamish State Park Boundary at SE 56th Street, south to City boundary.	279	39 (63)
East Fork Issaquah Creek	X through Z and ZZ	Stretches from confluence with Mainstem Issaquah Creek, east to eastern City boundary near I-90.	84	12 (19)
Lake Sammamish	Lk_Sam01 through Lk_Sam03	Located along the south end of Lake Sammamish. Includes lake shoreline of Greenwood Point Neighborhood and Lake Sammamish State Park PAA. Also includes shoreline of the mainstem Issaquah Creek within Lake Sammamish State Park PAA.	356 total; 78 within City limits; 278 within PAA	49 (18)

2.2 Inventory Data Sources

A number of local, regional, state and federal agency data sources, maps, and technical reports were reviewed to compile this inventory and characterization report. This includes information pertaining to watershed conditions and ecosystem-wide processes as well as data on the land use patterns and ecological conditions of Issaquah's shorelines. Assessing conditions at these two distinct geographic scales (the watershed scale and the shoreline reach scale) is a key requirement of the SMP update process[13].

One of the primary information and data sources used to prepare this report was the *Final Stream Inventory and Habitat Evaluation Report* (Parametrix, 2003), hereafter referred to as the Stream

[12] Does not include open water areas, however does includes all known associated wetlands, floodways, and floodplains within 200 feet of floodways based on existing mapping sources (see Map 1).

[13] WAC 173-26-201

Inventory. The Stream Inventory describes the ecological conditions associated with the Mainstem Issaquah Creek, East Fork Issaquah Creek[14] and provides information for the portion of the Lake Sammamish shoreline that was within the City boundary at the time the report was prepared (2003).

This inventory and characterization report summarizes the major findings of the Stream Inventory and supplements or updates those findings where new information is available or where conditions have changed. This report also includes information for the Greenwood Point area of the Lake Sammamish shoreline, which was annexed in 2005, and an additional reach of the East Fork Issaquah Creek, which was previously believed to be upstream of the 20 cfs mean annual flow threshold.

Under WAC 173-26-201, local governments are required to gather and incorporate all pertinent and available information, existing inventory data and materials from state agencies, affected Indian Tribes, watershed management planning efforts, port districts, and other appropriate sources. Local governments are required to inventory, at a minimum, the elements listed in WAC 173-26-201(3)(c). These items are shown in the first column of Table 2-2 below. The second column indicates where in this report those elements are addressed.

Table 2-2 Guide to Addressing Shoreline Inventory Requirements

Inventory Requirements (WAC 173-26-201)	Report Sections that Address Requirements
(i) Shoreline and adjacent land use patterns and transportation and utility facilities, including the extent of existing structures, impervious surfaces, vegetation and shoreline modifications in shoreline jurisdiction. Special attention should be paid to identification of water-oriented uses and related navigation, transportation and utility facilities.	Section 4.1.4 Section 4.2.4 Section 4.3.4
(ii) Critical areas, including wetlands, aquifer recharge areas, fish and wildlife conservation areas, geologically hazardous areas, and frequently flooded areas. See also WAC 173-26-221.	Section 4.1.1 Section 4.2.1 Section 4.3.1
(iii) Degraded areas and sites with potential for ecological restoration.	Sections 4.1.3.3; 4.2.3.3; 4.3.3.3 Section 5.2.1.1 and 5.2.1.3 Section 5.2.2.1 and 5.2.2.3 Section 5.2.3.1 and 5.2.3.3
(iv) Areas of special interest, such as priority habitats, developing or redeveloping harbors and waterfronts, previously identified toxic or hazardous material clean-up sites, dredged material disposal sites, or eroding shorelines, to be addressed through new master program provisions.	Sections 4.1.4.4; 4.2.4.4; 4.3.4.4 Section 5.1 Section 5.2.1.2; 5.2.2.2; 5.2.3.2
(v) Conditions and regulations in shoreland and adjacent areas that affect shorelines, such as surface water management and land use regulations. This information may be	Section 1.4

[14] The Stream Inventory also described the North Fork Issaquah Creek and Tibbetts Creek, although they are not shorelines regulated under the SMA.

Inventory Requirements (WAC 173-26-201)	Report Sections that Address Requirements
useful in achieving mutual consistency between the master program and other development regulations.	
(vi) Existing and potential shoreline public access sites, including public rights of way and utility corridors.	Section 4.1.4.4 Section 4.2.4.4 Section 4.3.4.4
(vii) General location of channel migration zones, and flood plains.	Appendix A: Map 3
(viii) Gaps in existing information. During the initial inventory, local governments should identify what additional information may be necessary for more effective shoreline management.	No major data gaps were identified
(ix) If the shoreline is rapidly developing or subject to substantial human changes such as clearing and grading, past and current records or historical aerial photographs may be necessary to identify cumulative impacts, such as bulkhead construction, intrusive development on priority habitats, and conversion of harbor areas to nonwater-oriented uses.	Section 3.1.1 Section 4.1.4.7 Section 4.2.4.7 Section 4.3.4.7
(x) If archaeological or historic resources have been identified in shoreline jurisdiction, consult with the state historic preservation office and local affected Indian tribes regarding existing archaeological and historical information.	Section 4.1.4.6 Section 4.2.4.6 Section 4.3.4.6

The Guidelines require local governments to analyze gathered information before they adopt specific master program provisions. Required elements of analysis, called out specifically in WAC 173-26-201, are listed in the first column in Table 2-3 below. The second column indicates where in this report those elements are addressed.

Table 2-3 Analysis of Shoreline Issues Of Concern

Analysis Requirements (WAC 173-26-201)	Report Sections that Address Requirements
Characterization of functions and ecosystem wide processes	Chapter 3
Shoreline use analysis and priorities	Sections 4.1.4.1; 4.2.4.1; 4.3.4.1 Sections: 4.1.4.2; 4.2.4.2; 4.3.4.2 Also see the Shoreline Use and Public Access Technical Memorandum included as Appendix C
Addressing cumulative impacts in developing master programs	Section 5.2.1.2; 5.2.2.2; 5.2.3.2 Cumulative impacts will also be assessed in a Cumulative Impacts Analysis that will be prepared after draft shoreline regulations are available.
Shorelines of statewide significance	Lake Sammamish is a shoreline of statewide significance. The Lake's shorelines are evaluated in sections 4.3 and 5.2.3.

Analysis Requirements (WAC 173-26-201)	Report Sections that Address Requirements
Public access needs and opportunities	Sections 4.1.4.4; 4.2.4.4; 4.3.4.4 Also see the Shoreline Use and Public Access Technical Memorandum included as Appendix C
Enforcement and coordination with other programs	Coordination with other programs is addressed in sections 1.4. Enforcement will be addressed by the updated shoreline regulations.
Water quality and quantity	Sections: 4.1.2; 4.2.2; 4.3.2 Water quality is discussed at the basin scale in Appendix B.
Vegetation conservation	The condition of shoreline vegetation is discussed in sections 4.1.3.2; 4.2.3.2; 4.3.3.2 Conservation is discussed in sections: 5.2.1.3; 5.2.2.3; 5.2.3.3 Specific vegetation conservation actions will be discussed in the Restoration plan.
Special area planning	There are no areas chosen for special analysis at this time.

Because the 2003 Stream Inventory was prepared to meet the requirements of an earlier version of the state shoreline Guidelines[15], it includes all of the standard shoreline inventory elements. Also, because the Stream Inventory was prepared at a level of detail that exceeds what is now required for shoreline inventories, it provides an excellent basis for this report and the subsequent SMP update steps. No major data gaps were identified.

The following aerial photographs and Geographic Information Systems (GIS) data were used to assess shoreline conditions:

- City of Issaquah GIS database (2007);
- King County GIS database (2007); and
- King County aerial photos (2002 and 2007).

A series of maps depicting shoreline and watershed attributes accompanies this report as Appendix A. A list of the Appendix A map themes is shown in Table 2-4. A complete list of data sources used to compile the report is included in Chapter 6.

[15] State Guidelines adopted in 2000 were challenged in court and eventually invalidated. The state adopted the current Guidelines in 2003 after extensive negotiation, mediation, and public input.

Table 2-4 Shoreline Map List (Appendix A)

Map Title	Scale	Map No.
Shoreline Planning Area	City	1
Regional Context	Region	2
Topography and Hydrology	City	3
Geology	City	4
Soils	City	5
Geologic Hazards	City	6
Fish and Wildlife Habitat	Reach	7 – 11
Riparian and In-stream Conditions	Reach	12 - 16
Comprehensive Plan Land Use Designations	City	17
Zoning and Public Access Sites	Reach	18 - 22
Land Cover	City	23
Impervious Surface	Reach	24 - 28
Transportation and Utilities	City	29
Parks, Open Space, and Public Access	City	30
Hydrology Important Areas	Regional	31
Hydrology Level of Alteration	Regional	32
Protection and Restoration Areas	Regional	33
Lake Sammamish Shoreline Modification Analysis	Reach	34 - 36

2.3 Characterizing Ecosystem-wide Processes and Shoreline Functions

The SMA Guidelines require local jurisdictions to evaluate ecosystem-wide processes and their relationship to shoreline ecological functions. Ecosystem processes generally refer to the dynamic physical and chemical interactions that form and maintain aquatic resources at the watershed scale. These processes include the movement of water, sediment, nutrients, pathogens, toxins, and wood as they enter into, pass through, and eventually leave the watershed.

For this report, ecosystem processes were characterized using the methods described in *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley et al., 2005). The approach develops general predictions of how water moves within a watershed based topography, soils, geology, climate and other hydrogeologic factors. Across a watershed, these factors govern the patterns of surface water and groundwater flow between upland and aquatic areas. The approach focuses on water flow patterns because water movement underlies most of the other physical and chemical interactions that occur in a watershed (Stanley et al., 2005).

Using the characterization methods and working on the City's behalf, Department of Ecology staff prepared an initial set of maps that identify the most important areas in the watershed for maintaining hydrologic processes. Ecology also identified areas where water flow processes have been altered by human activities. By considering the relative degree of importance and extent of alteration for each subbasin in the watershed, management strategies and priorities for protection and restoration can be identified.

The purposes of the ecosystem-scale analysis are to highlight the relationship between key processes and aquatic resource functions, and to describe the effects of land use on those key processes. The goals are to:

- Identify and map areas in the watershed that are most important to processes that sustain shoreline resources;
- Determine the extent to which those important areas and their processes have been altered; and
- Identify management strategies and potential opportunities for protecting or restoring these areas.

The results of the analysis are provided in Chapters 3 and 5.

2.4 Inventory and Characterization Approach for Shoreline Reaches

The inventory and characterization of Lake Sammamish, Mainstem Issaquah Creek, and East Fork Issaquah Creek at the shoreline reach scale is intended to describe conditions adjacent to each of the SMA-regulated water bodies. The characterization relies heavily on the City's Stream Inventory, which includes a detailed assessment of streams and shorelines within the Issaquah City limits (Parametrix, 2003)[16]. Parametrix collected information concerning wetlands, priority habitats and species, and land use to provide an overall picture of the shoreline environment. In addition, they conducted detailed instream surveys for Mainstem Issaquah Creek and the East Fork Issaquah Creek to assess the following 10 stream attributes: bank condition, large woody debris (LWD), passage barriers, water temperature, riparian condition, substrate composition in spawning areas, embeddedness in spawning areas, pool frequency, benthic invertebrate community, and channel pattern and connectivity.

Parametrix (2003) also analyzed the instream data according to the criteria outlined in the Urban Stream Baseline Evaluation Method (USBEM) developed for rivers and streams in the King-Pierce-Snohomish county region (R2 Resource Consultants et al. 2000) and assigned a rating of Good, Fair, or Poor to each attribute based on specific criteria.

The Stream Inventory represents the best available information concerning the physical habitat of the City's shoreline streams. However, some of the species use data and land use information provided in the Stream Inventory is slightly outdated and some reaches of the City shorelines

[16] The study area for the Stream Inventory differed slightly from the City's shoreline planning area described in section 1.3. The Stream Inventory's instream survey study area included the area within 100 of the OHWM and the Stream Inventory's wetlands, riparian vegetation, and priority habitats inventory study area included the area 250 feet from the OHWM. In general, this difference does not change the characterization of the City's shoreline planning area. Where the difference in study area size affects the conclusions of this report, it is noted.

were not covered. This report includes up-to-date information on land use, zoning, public access, impervious surface, water quality, priority habitats and species, and lake shore modifications such as docks and bulkheads. It also describes the additional shoreline reaches along the East Fork Issaquah Creek (Reach ZZ) and the Lake Sammamish shoreline within the City's PAA that were not included in the Stream Inventory.

3.0 ECOSYSTEM-WIDE CHARACTERIZATION

This section describes general ecological conditions and key ecosystem processes that occur within the Lake Sammamish watershed. Although the focus of this report and of the SMP update in general is on conditions within the shoreline planning area (see section 2.1), the state shoreline Guidelines require local jurisdictions to look beyond the SMA jurisdictional boundaries to "assess the ecosystem-wide processes to determine their relationship to ecological functions present within the jurisdiction[17]."

> **Watershed**: The drainage area contributing water, organic matter, dissolved nutrients, and sediments to a stream, lake, wetland, or other water body. This includes the area that contributes groundwater to aquatic ecosystems, which may be different from the area contributing surface water.
>
> (Stanley et al., 2005)

The City's SMP regulates use and development adjacent to Issaquah Creek, the East Fork Issaquah Creek and Lake Sammamish, but these areas are affected by actions that occur throughout the City and throughout the watershed. Many of the land use decisions and actions that affect Issaquah's shorelines are not under the jurisdiction of the SMA and may be completely outside of the City's control. Nevertheless, effective management of the City's shorelines requires an understanding of the broader ecosystem, which in this case is the contributing watershed[18]. Additional information of ecosystem processes is provided in Appendix B.

3.1 Lake Sammamish Watershed Overview

The Lake Sammamish watershed includes portions of the cities of Issaquah, Bellevue, Redmond and Sammamish as well as unincorporated areas of King and Snohomish Counties. The watershed is part of the greater Cedar – Sammamish River Water Resource Inventory Area (WRIA) known as WRIA 8, which includes two major river systems, the Cedar and Sammamish Rivers, as well as Lake Sammamish, Lake Washington, Lake Union, and numerous tributaries to each (See Map 2, Regional Context, in Appendix A).

WRIA 8 is located predominantly within the borders of King County, with the northwest portion extending into Snohomish County. It has the highest human population of any WRIA in the state with nearly 1.5 million residents (Kerwin, 2001). The boundaries of WRIA 8 follow topographic features that define the drainage divide between the Snohomish WRIA (WRIA 7) to the east, and the Green/Duwamish WRIA (WRIA 9) and Puget Sound to the west (Kerwin, 2001). The majority (approximately 86 percent) of WRIA 8 is in the Puget Lowlands physiographic region, while the upper (eastern) portion of the WRIA is in the Cascade foothills.

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[17] WAC 173-26-201(3)(d)(i)

[18] This information on the watershed processes is also important in restoration planning since some of the restoration actions that may improve the health and sustainability of the City's shorelines may be located outside of shoreline jurisdiction. A separate Restoration Plan will be prepared at a later date as part of the SMP update process.

The City of Issaquah lies entirely within the Lake Sammamish watershed. The majority of the City drains to Issaquah Creek, with smaller areas draining either directly to Lake Sammamish, or through the East Lake Sammamish basin. Issaquah Creek is the single largest tributary flowing into the lake, draining the slopes of Cougar, Tiger, and Squak Mountains north to the lake. The stream network begins around 3,000 feet above sea level, and flows down to the lake at around 30 feet above sea level.

The Issaquah Creek basin covers approximately 61 square miles and includes four major branches, Tibbetts Creek to the west, the Mainstem to the south, and the North and East Forks of Issaquah Creek to the east. Approximately 15 percent of the Issaquah Creek basin lies within City boundaries.

The Issaquah Creek basin is one of the three most significant basins in King County in terms of salmon production and the upper and middle portions of the basin are a Regionally Significant Resource Area because of the exceptional fisheries habitat and undeveloped character (Kerwin, 2001). Eight species of salmonids use the Issaquah basin including an early-run kokanee stock. Carry and Holder creeks in the upper Issaquah Creek basin provide particularly excellent habitats for salmonids.

According to GIS analysis of available data, the Issaquah Creek basin includes approximately 2,827 acres of inventoried wetlands (roughly 6.2% of the basin area)[19]. Some of most valuable wetlands are located in the lower basin inside the City limits. Approximately 285 acres of wetland have been mapped in the City of Issaquah; approximately 82 acres of wetlands (11 individual wetlands) occur within the City's shoreline zone (Parametrix, 2003). Many of the wetlands in the lower basin provide important habitat for wetland-associated species and perform water quality functions related to nutrient removal (i.e., denitrification).

Wetlands within the lower basin tend to occur near the major waterbodies such as Lake Sammamish, Lake Tradition, and Round Lake and in the river valleys (i.e., the mainstem, East Fork, and North Fork of Issaquah Creek; Tibbetts Creek, etc). These wetlands provide important habitat functions. For example, wetlands near the mouths of Tibbetts and Issaquah creeks provide habitat for waterfowl, small mammals, and reptiles and amphibians. These wetlands also provide hydrologic support. Wetlands in the upper basin may have greater potential to attenuate downstream peak flows and supplement baseflows than wetlands located farther downstream (WSDOT 2000). However, many high quality wetlands occur in the lower basin. One example is the wetland complex at the downstream end of Issaquah Creek near Pickering Place. This Pickering wetland complex-- like many depressional wetlands in the basin-- is somewhat disconnected from its floodplain. Restoring the wetland's connectivity to Issaquah Creek would improve its function and could have improve the water quality of the creek and on Lake Sammamish.

[19] This includes wetlands identified in the King County Wetlands inventory, the National Wetlands Inventory (NWI) and NOAA C-CAP data.

The City of Issaquah is located primarily on the valley floor between the steep hillsides of Tiger, Squak and Cougar Mountains and the southern end of Lake Sammamish. Most of the City's early development was located on the valley floor, where the historic downtown is located. Today that area has limited room to accommodate new development; more recent development has occurred on the adjacent foothills.

3.1.1 Historical Changes to the Watershed

As is the case with much of the Puget Sound Lowlands, land cover within the Lake Sammamish watershed has been extensively modified. Coal mining and timber harvesting were the initial instigators of change beginning in the late nineteenth century; more recently urban development has been the primary driver of land cover change. Significant development of the Lake Sammamish watershed occurred as population densities increased substantially in the 1980s (Kerwin, 2001).

These alterations have directly modified the upland plateau, hillslopes, floodplains, channels, riparian areas and the lake shore to allow for the development of urban and transportation infrastructure. These modifications have also have altered geomorphic processes that shape surficial features (Montgomery et al, 2003).

The installation of the Ballard Locks in 1914 noticeably changed Lake Sammamish, dropping the water levels in the lake by about 6 feet. This decrease in typical water levels drained extensive areas of wetland on the Issaquah Creek delta, and along the entire length of the Sammamish River (Kerwin, 2001, Carey, 2003). The drop in lake elevation also caused smaller-scale geomorphic changes as the stream channels that flow into the lake were forced to incise to match the new base level. Currently a weir at the north end of the Lake, within Marymoor Park, controls the outflow from the Lake into the Sammamish River.

Despite alterations in portions of the landscape, there are still significant areas of forest cover throughout the contributing basin. Past basin studies indicate that as much as 75 percent of the contributing basin is forested. Modeling efforts indicate that increases in peak flows are limited to less than 10 percent of the fully forested condition (Kerwin, 2001, City of Issaquah, 2004a).

3.1.2 Land Use and Habitat

Land use within WRIA 8 is diverse and varies considerably across the watershed. The upper watershed, in the Cascade foothills, is largely forest land including both protected areas and commercial forests. Low-density residential, commercial forestry, and agricultural lands occur in then vicinity of the smaller streams in the upper watershed. Residential, industrial, and commercial uses prevail in the lower watershed (Kerwin, 2001). This pattern generally applies to the Sammamish watershed as well. The upper watershed is largely in forest uses, while the lowlands are generally in low- and moderate density residential uses with areas of commercial and industrial uses in the cities.

Lands in the upper Issaquah Creek basin within King County's jurisdiction are primarily zoned for forestry and rural residential uses. As of 2001, 30 percent of the basin was zoned forest production, 12 percent was within the urban growth boundary, and the remaining 58 percent was zoned rural. Over 40 percent of the land is in public ownership with Washington Department of

Natural Resources, Washington State Parks, King County Parks, and City of Issaquah Parks. The population in the basin is projected to increase by 18 percent by 2020 (http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0631#specialstudies).

Land use in the City is a mixture of residential, commercial and open space (Map 18). According to the City's Comprehensive Plan (2004b), approximately a third of the City (35 percent) is designated for single family residential. Five percent of the City is designated for multi-family development and approximately 16 percent is designated for commercial, retail, or office. Community facilities and conservancy areas comprise approximately one-third of the City (31 percent). The remainder is designated for urban villages, which contain a mix of uses (Map17).

The Issaquah Creek basin provides valuable habitat for many species of fish and wildlife. King County (2007) identified the Issaquah Creek basin (outside the City boundaries) as a High Forest Wildlife Value Area (outside of shoreline jurisdiction) with defined wildlife habitat 'networks' in the upper basin (including along some of the streams in County shoreline jurisdiction) (Figure 3-1). This includes areas where large (≥157 acres) forest patches are present and potentially connected to other large forest patches. Data are based on 2002 land cover data obtained from the University of Washington (King County, 2007). These forests are assumed to indicate areas of significance to forest interior wildlife species. Wildlife habitat networks were mapped to connect publicly owned and protected lands to one another via natural corridors such as rivers.

King County (2007) also identified the following terrestrial species of concern in the Issaquah Creek basin:

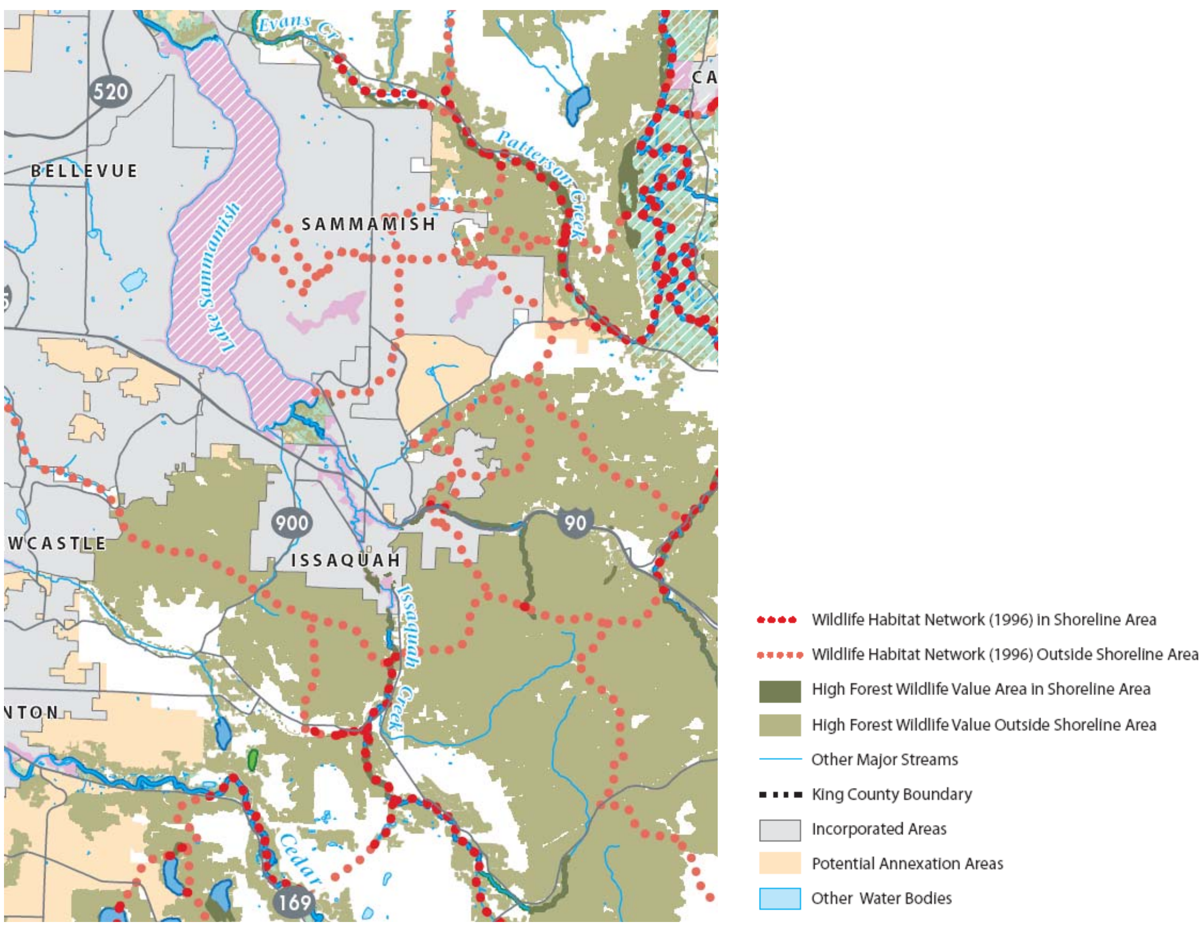
- Bald eagle
- Great blue heron
- Osprey

Available data suggests that stream corridors and intact forest patches in the basin provide valuable habitat for terrestrial and aquatic wildlife species. Mammals are an important part of the ecological food web and some species also play a role in the physical and biological processes of lakes and streams. The American beaver alters stream and pond environments due to its dam building habits. Bats consume large quantities of insects each night as they feed over open water, and they roost beneath the bark of mature trees or in caves. Some species, such as mice and voles, play important roles in seed dispersal and soil fertility. Maintaining enough undeveloped areas in the basin to support the prey base and movement patterns of mid- to large-sized mammal species such as black bear, black-tailed deer, and coyote is important. Small mammal abundance and species diversity are affected by the amount of undeveloped area and the condition and size of riparian zones.

Land use and development patterns also affect the abundance and diversity of aquatic invertebrate communities. For example, invertebrate and amphibian species that depend on the aquatic environment for a portion of their life cycle can be affected by the extent and quality of riparian buffers bordering a stream. Stream invertebrates and amphibians are also important in the food web and they affect nutrient cycling. In high densities, amphibian tadpoles control algae growth that has potential to lead to eutrophication (Johnson and O'Neil, 2001). Amphibian species likely to occur in the Issaquah Creek basin are closely associated with and breed in riparian and open water habitats. Many amphibians also have partial or full terrestrial life stages and that require large continuous tracts of mature forest for foraging and dispersal as adults.

The value of relatively wide tracts of undisturbed forest for providing bird habitat is well known. Bird species diversity and abundance depends upon several factors, including but not limited to plant community composition, structural features, disturbance levels, and riparian buffer width. Many of the birds that are associated with and breed in riparian areas are also associated with upland forest and agricultural habitats. Some birds are usually only found in riparian areas that are connected to larger forest tracts, but others are more adaptable in terms of their habitat needs. Forest-dwelling species such as band-tailed pigeon and Wilson's warbler are likely to require larger, undisturbed buffers than more generalist and edge-adapted species such as American robin and black-capped chickadee.

Figure 3-1 High Landscape Forest Value and Wildlife Habitat Network Areas
(source: King County, 2007)



3.2 Ecosystem Processes

3.2.1 Lakes

Lake environments, like Lake Sammamish, are influenced by the volume of water flowing into and out of the lake, the hydraulic residence time, the degree and timing of density/temperature stratification, and the internal cycling of nutrients (particularly phosphorous and nitrogen). The movement of water, sediments, organic matter, and nutrients/pathogens through the watershed plays a key role in determining how lakes function.

The relationship between the volume of water entering a lake through precipitation, groundwater, overland runoff, and/or stream flow and the water exiting the lake via evapotranspiration, surface outflow, and seepage into groundwater is one of several fundamental determinants of lake ecology. Lake Sammamish is primarily fed by surface water inputs, as opposed to groundwater inputs, and therefore tend to be a high risk for water quality degradation. This is especially true because the watershed is becoming more urbanized and impervious surfaces have displaced permeable surfaces thereby altering the intensity, volume, timing, and duration of stormwater runoff. Higher peak flows in the watershed tends to increase the transport of bioavailable forms of phosphorus and nitrogen, which can alter the trophic state (nutrient status) of the lake and create harmful conditions for fish and wildlife. Loss of water storage areas can exacerbate other effects of urbanization (such as increases in peak flows) by disrupting natural flood desynchronization functions.

Increased urbanization can also affect sediment delivery to the lake, which affects water quality The primary sediment generation and transport processes are: (1) sediment buildup and wash-off from developed areas and construction sites, (2) landslides in the upper basin, and (3) bank erosion of tributary streams. The generation, movement, and storage of sediment are largely driven by hydrologic factors and generally controlled by physical conditions such as topography (gradient), land cover (vegetation), soil characteristics (erodibility), and the transport capacity of moving water, including Issaquah and Tibbetts Creeks, which together deliver most of the sediment that reaches Lake Sammamish (Ecology, 2005). The alluvial delta at the southern end of Lake Sammamish has formed as the lake assimilates the sediment load of these two streams. Nelson (undated) estimated the average annual growth rate of the delta to be approximately 2,600 tons/year, which compares to an estimated fine sediment input of 3,800 tons/year from Issaquah Creek. An unknown amount of this fine sediment input is carried in suspension out into the lake.

Sediment is a major transport vector for phosphorus, which is the primary nutrient of concern in freshwater systems. Therefore, the more sediment that washes into the lake the greater the potential phosphorus load. If present in excess amounts, nutrients can cause nuisance algal blooms or, on occasion, toxic algal blooms.

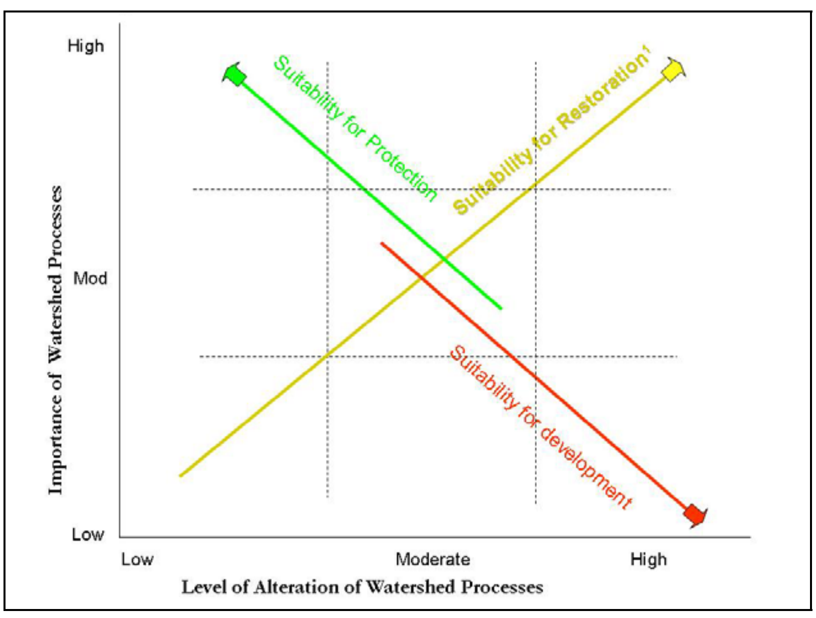
The link between urbanization and decreased water quality within Lake Sammamish has been well-established for some time, beginning with the efforts by Metro in the 1960s to limit the impacts of non-point pollution including excess nutrient loading on the major lakes in the Puget Lowlands. Gradual urbanization of all of the basins draining to Lake Sammamish has increased nutrient and bacteria loading to the lake systems, which effects: (1) lake clarity, (2) growth of algae and submerged aquatic vegetation, and (3) increased bacteria levels.

3.2.2 Streams

Appendix B provides additional information on interactions between ecosystem processes and ecological functions affecting streams in and around the City of Issaquah. This includes background information on the factors that control how processes operate and general descriptions of the key processes that shape shoreline functions.

One of the key processes driving ecosystem health is hydrology or water flow. Department of Ecology staff working in coordination with the City of Issaquah identified the important areas for water flow process and the extent to which these areas have been altered (See maps 31 and 32 in Appendix A). Ecology used a three-step framework to create a relative ranking of where development, protection and restoration would be most appropriate at the watershed scale based on this analysis. The framework develops a High, Moderate, or Low score for both *importance* and *alteration* for each subbasin within a study area. The scores for both importance and alteration are then taken together to develop an overall ranking of appropriate actions. Important areas include: 1) rain on snow areas; 2) surface storage (historic depressional wetlands) and floodplains; 3) recharge areas; 4) storage capacity areas; and 5) discharge areas. The types of alterations that the framework considers are: 1) forest clearing; 2) filling of depressional wetlands; 3) channelization of streams; 4) road presence and density; and 5) impervious surface. The analysis helps identify a set of actions that would be most appropriate for each subbasin within the watershed. Figure 3-2 shows how the rankings are used to prioritize where development, protection and restoration could occur in the watershed to target a net gain in ecosystem functioning (See Chapter 5 for more information. Also see the shoreline restoration plan, to be prepared under a separate cover).

Figure 3-2 Setting Priorities for Protection and Restoration of Subbasins at the Watershed Scale
(Source: Stanley et. al., 2005)



In general, areas important for hydrological processes in Issaquah are the high elevation rain-on-snow zones on highly permeable deposits (other higher elevation areas occur over shallow bedrock, thereby limiting infiltration and storage potential) and the lower alluvial valley, extending up the North Fork of Issaquah Creek. This pattern captures an extensive former wetland area as well as groundwater recharge areas (Figure 3-3).

The areas of High importance include an area in the southeastern portion of the Issaquah Creek watershed along the highest elevations on the east side of the valley. Other areas mapped as High include some areas at the intersection of significant tributaries to the Mainstem of Issaquah Creek. Areas of Medium importance are mapped on the middle slopes on the eastern side of the watershed, and much of the low elevation area that is s now covered downtown. The only areas mapped as Low importance occur in the downstream portion of the Laughing Jacobs subbasin, and in a small subbasin at the drainage divide in the easternmost portion of the City.

The areas mapped as Low importance cover a small percentage (2 percent) of the overall study area. These areas appear to capture units that are low in elevation, have few historical wetlands, and are at least partially altered. Alterations follow similar, but converse, patterns as described for the important areas. Areas with relatively Low levels of alteration are focused on areas of intact forest cover in the higher elevations in the southeastern portion of the study area, and at Lake Sammamish State Park (Figure 3-4). Areas with Moderate alterations are distributed throughout the study area, and typically focus on smaller communities or clusters of residential development. The High levels of alteration occur within the developed downtown core, and in north of the North Fork in the Overdale subbasin.

Figure 3-3 Important Areas for Water Flow Processes, Issaquah Creek Basin (Source: Ecology)

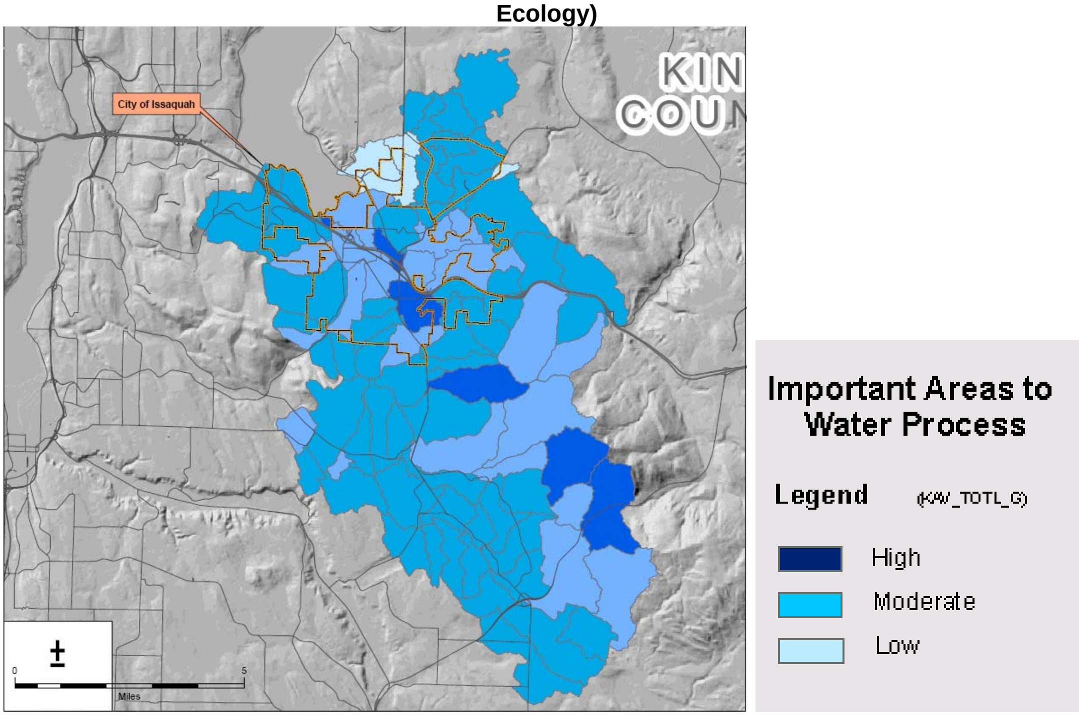
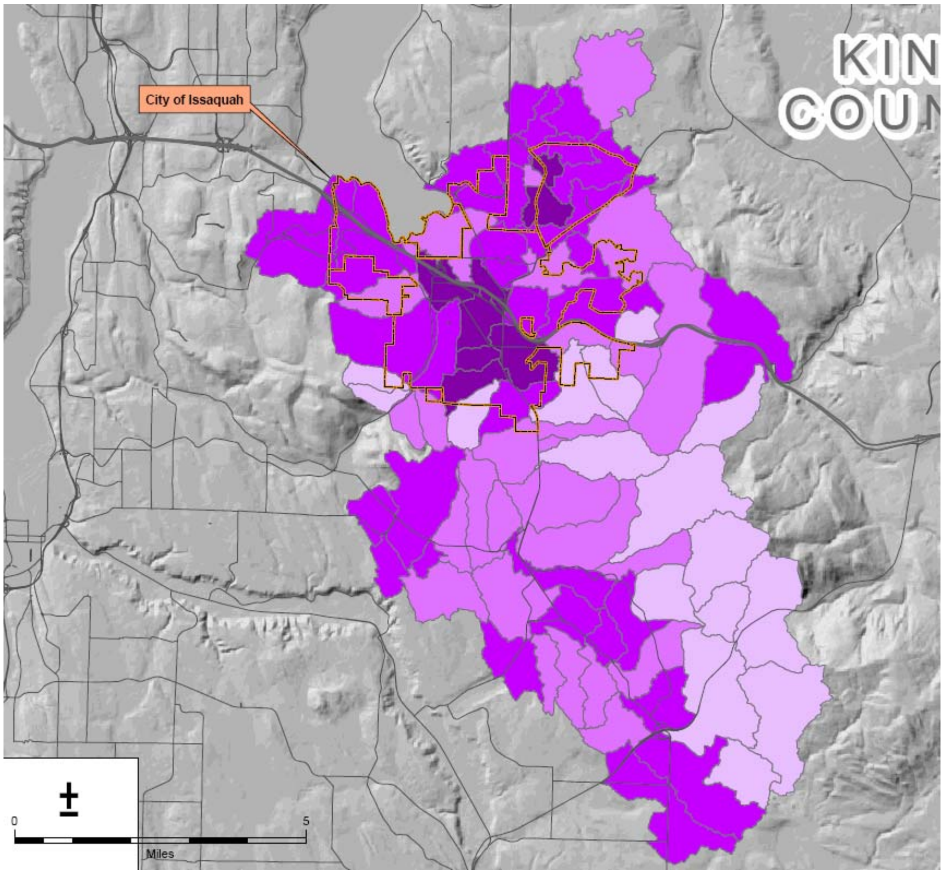


Figure 3-4 Areas where Water flow Processes are Altered, Issaquah Creek Basin (Source: Ecology)



High Alteration
Low Alteration
Moderate – Low Alteration
Moderate – High Alteration

4.0 REACH INVENTORY AND ANALYSES

4.1 Mainstem Issaquah Creek

The Mainstem Issaquah Creek flows over 17.25 miles from its headwaters on Tiger Mountain north to Lake Sammamish. The lower reaches of the creek occur within the City, eventually flowing into the lake at Lake Sammamish State Park. The Mainstem drains approximately 61 square miles, but only about 3.2 of those square miles occur within City limits (City of Issaquah, 2004b).

The Mainstem Issaquah Creek has been significantly altered as a result of land development and urbanization (Parametrix, 2003; City of Issaquah, 2004a; Watershed Company, 2006). Two of the most notable alterations are: changes in the natural flow regime and changes in the condition and stability of the channel banks.

Changes to the natural flow regime have unbalanced the sediment transport capacities, caused channel scour, and simplified instream habitat characteristics by altering the channel morphology. Channel banks have been extensively armored or hardened to prevent erosion and protect adjacent land and structures. The bank modifications have contributed to channel straightening and loss of side-channel habitats, which are very important for fish. The following sections describe specific conditions of the stream channel and the adjacent shoreland areas.

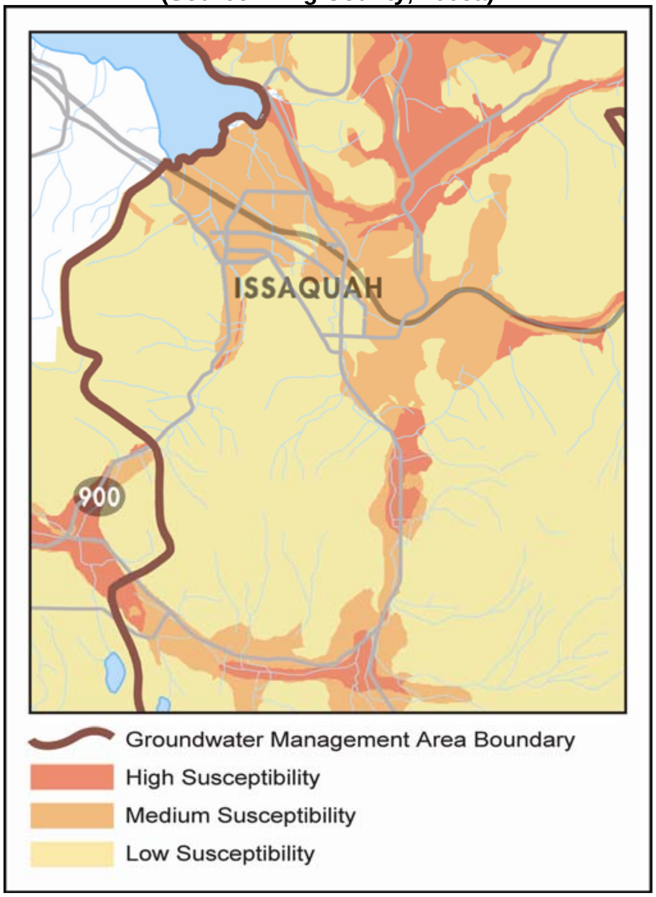
4.1.1 Critical Areas

4.1.1.1 Aquifer Recharge Areas

The City of Issaquah is part of the Issaquah Creek Valley Groundwater Management Area (King County Groundwater Protection Program). The Groundwater Management Area includes the Tibbetts Creek and Issaquah Creek watersheds–a 93-square mile area located east and southeast of Lake Sammamish. Almost all of the water used for private, municipal, industrial and agricultural purposes in the Issaquah Creek Valley Groundwater Management Area is provided by groundwater sources (Figure 4-1). The City of Issaquah has joined the Cascade Water Alliance, a regional purveyor. Imported water will supplement the City's water supply and reduce sole reliance on groundwater.

The Mainstem Issaquah Creek flows over the Lower Issaquah Valley (LIV) aquifer with the depth to the aquifer ranging from zero to greater than 20 feet (Golder, 2003). Groundwater discharge from the shallow parts of the aquifer is important for maintaining stream flows in Issaquah Creek (Golder, 2003). However, the bulk of the aquifer recharge occurs in coarse glacial outwash deposits located outside the Mainstem shoreline planning area on the upland plateau on the east side of the valley.

Figure 4-1 Issaquah Creek Valley Groundwater Management Area
(Source: King County, 2005a)



King County has mapped the Issaquah Creek Valley Groundwater Management Area for susceptibility to groundwater contamination. Mapping is based on soil/geology permeability and depth to groundwater. According to King County, the lower stream reaches (Lk_Sam02, A and B) and Reach F cross areas identified as moderately susceptible to groundwater contamination. Reach H crosses an area identified as highly susceptible to groundwater contamination (King County, 2005). Otherwise, the areas along the Mainstem are considered to have low susceptibility to groundwater contamination.

The City has identified Critical Aquifer Recharge Areas (CARAs)--areas that are important sources of potable water and areas where groundwater is susceptible to contamination. Most of the Mainstem planning area upstream of I-90 is within a designated Class 1 or Class 2 CARA, which represents the 1- to 5- and 10-year wellhead capture zones, respectively. The capture zones define the area surrounding water supply wells where contamination would occur during a specified time period (e.g., 1 year, 5 years, etc.) (Table 4-1). Class 3 CARAs include areas identified with high infiltration capability to recharge the aquifer.

CARAs are protected through implementation of the City's critical areas ordinance (IMC 18.10.796) and through the groundwater quality and quantity protection standards in IMC 13.29 and 13.28, respectively. These regulations mandate the use of best management practices to prevent contaminants from entering the aquifer and restrict certain types of land use activities that could lead to groundwater contamination. In the Class 3 CARA, City standards require new development to infiltrate stormwater to recharge the aquifer and maintain stream baseflows.

4.1.1.2 Flood Hazard Areas

The City defines areas of special flood hazard to include the land in the floodplain subject to a 1 percent or greater chance of flooding in any given year (also known as the 100-year floodplain). The Federal Emergency Management Agency (FEMA) flood insurance maps define the regulatory floodplain and Areas of Special Flood Hazard along the Mainstem (see Map 3 in Appendix A). The width of both the floodplain and the floodway varies through the City depending on channel and floodplain geometry and the level of floodplain modification. The Mainstem floodplain width varies from about 350 feet near the confluence with the East Fork to over 2,500 feet near the mouth at Lake Sammamish (Table 4-1).

As noted in the City's Stormwater Management Plan (City of Issaquah, 2004a), flooding hazards occur alongside the Mainstem Issaquah Creek throughout the City. The City appears to be experiencing a general trend of increasing flood frequency and increased flood damages attributable to several factors:

- Continued development in the floodplain, which puts greater numbers of structures near the stream channel.
- Increased flood elevations due to reduced channel capacity. Sedimentation in the stream channel and fill in the floodplain and along streambanks have decreased the capacity of the stream to carry high flows.
- Larger peak flows due to additional impervious surface area within the watershed. Hydrologic modeling conducted by King County for the Issaquah Creek Basin Plan concluded that current levels of urbanization have caused flood peaks to increase by 8 percent.
- Larger peak flows caused by greater total storm precipitation in recent years, the product of an apparent upward trend in the long-term cycle of weather patterns.

To minimize flooding and flood damage, the City regulates placement of fill and construction of structures in 100-year floodplain[20]. Development proposals must not reduce the effective base flood storage volume of the floodplain and cannot reduce the hydraulic capability of the floodplain to convey floodwaters during the base flood event. The City also requires compensatory storage such that there is no net increase in fill within the floodplain.

4.1.1.3 Geologically Hazardous Areas

Areas along the Mainstem of Issaquah Creek have the potential for erosion, seismic risk, and landslides (see Map 6 in Appendix A). In general, seismic hazards are focused in areas where soil liquefaction could occur. These areas include the wetland and drained wetland areas

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[20] IMC 16.36

Table 4-1. Summary Table of Critical Areas and Water Quality in Mainstem Issaquah Creek

Reach	Geologic Hazard	Aquifer Susceptibility	Floodplain Width (ft)	Water Quality Assessment (Category 4 or 5)[21]
Lk_Sam02[1]	Seismic	Low and Medium	2,500	Fecal Coliform (4a)
A	Seismic	Medium	780	Fecal Coliform (4a) DO (5)
B	Seismic	Medium	400 - 1,175	Fecal Coliform (4a) DO (5)
C	No	Medium	400	Fecal Coliform (4a) DO (5)
D	No	Medium	350	Fecal Coliform (4a) DO (5)
E	No	Medium	650	Fecal Coliform (4a) DO (5)
F	No	Medium	750	None
G	No	Medium and High	320	None
H	No	Low, Medium, and High	750	None
Source:	King County GIS	Issaquah GIS data	FEMA mapping	Ecology 303(d) list

[1] Reach Lk_Sam02 include the section of Main Stem Issaquah Creek that flows through Lake Sammamish State Park (PAA)

contiguous with the southern portion of Lake Sammamish and the wetland area near where the Mainstem enters the City boundary. Erosion and landslide hazards are mapped near the main channel confluence with the East Fork, outside the shoreline planning area.

To minimize health and safety risks, the City requires a 10 to 50-foot buffer to be established adjacent to landslide and steep slope hazard areas (IMC 18.10.560 and IMC 18.10.580) The City also requires special studies and mitigation to ensure that adverse effects of development in erosion, landslide, steep slope, seismic, and coal mine hazard areas are fully addressed. There appear to be mapped coal mine hazard areas Reaches G and H.

Channel Migration Zones

No formal mapping of channel migration zones using the methods of Rapp and Abbe (2003) has occurred within the City of Issaquah. The Stream Inventory provided some qualitative assessment of the presence and relative activity of channel migration, noting that, in general, the

[21] Category 5 waters are waters for which at least one characteristic or designated use is impaired, as evidenced by failure to attain the applicable water quality standard for one or more pollutants. Category 4a waters show that a characteristic use is impaired by a pollutant, but a Total Maximum Daily Load (TMDL) addressing that impairment has already been developed and been approved by the US EPA.

current channel migration zone can be approximated using the 100-year floodplain mapping (meaning the 1 percent annual chance of flooding area) (Parametrix, 2003). The 2003 Stream Inventory also identified four specific areas along the Mainstem where migration is both likely and has the opportunity to occur:

- Between SR 18 and just downstream of the Cedar Grove Road crossing (in King County);
- Downstream of the confluence of McDonald Creek (in King County);
- Downstream of SE 56th Street; and
- Within Lake Sammamish State Park.

While these areas might be susceptible to channel migration under natural conditions, significant infrastructure and development (e.g., I-90) along the lower reaches of Issaquah Creek confine the stream and effectively and may prevent channel shifts that might otherwise occur as a result of sediment buildup near the downstream end of the stream (Reaches A through D). Channel migration processes can and do occur in unconfined reaches within Lake Sammamish State Park (e.g., Reach Lk_Sam02) and in other reaches.

Ecology assessed CMZ potential in Issaquah using recent aerial photography and considering recent flooding events since 1989 and concluded that some of the areas identified in the 2003 Stream Inventory as 'stable' may not be constrained, as defined in the shoreline guidelines, from bank erosion or migration. The Stream Inventory states that all reaches upstream of Reach A are at least partially constrained, but photos suggest this may not be the case across the board (Olsen, Personal Communication, 2008). The Stream Inventory reports only 28% of the total length of Issaquah Creek in the City of Issaquah has 50 or more percent modified banks (a poor rating). The remaining 72% stream length has good (16%) and fair (56%) conditions. Good conditions range from 0-20% of bank length modified and Fair range from 21-49% of bank length modified. Where bank have not been modified, the stream is subject to erosion and migration. Also, some of the existing bank stabilization appears to be failing and not may not be sufficient to fully prevent channel migration in the future. Based on this analysis, Ecology concluded that the areas subject to migration would be more extensive than reported in the Stream Inventory (Olsen, Personal Communication, 2008). The preliminary 100-year floodplain map generally represents the channel migration area except at some actively eroding bends. At these points, placing the channel migration boundary in line with 200 feet from OHWM may be an adequate representation of the CMZ (Olsen, personal Communication, 2008).

The IMC does not specifically regulate development in channel migration zones.

4.1.1.4 Wetlands

The 2003 Stream Inventory reported that approximately 82 acres of wetlands (11 individual wetlands) were found within the Mainstem Issaquah Creek's shoreline planning area. Seven additional wetlands are adjacent to or hydrologically connected to wetlands in the shoreline area, and may have been part of a larger, connected wetland system prior to urban development.

Wetlands noted in the Stream Inventory as well as wetlands mapped by the National Wetlands Inventory (NWI) and the City (Parametrix, 2003) are shown in Maps 7 - 11[22].

The geomorphic setting for all of the identified wetlands is riverine, low-gradient alluvium and the water source for all of the wetlands is via lateral transport. The hydrodynamics or flow regime is low gradient unidirectional flow for all wetlands within the Mainstem Issaquah Creek reaches. Wetlands are a mixture of palustrine emergent (PEM), palustrine forested (PFO), and palustrine scrub/shrub (PSS) habitats.

Wetlands along Mainstem Issaquah Creek have the capacity to alter flood flows and remove sediments, toxicants, and nutrients from waters flowing through them. These riparian wetlands also absorb water and release it slowly over time, which helps to maintain stream flows, especially during the low-flow period of the year (Mitsch and Gosselink 1993). Wetland vegetation overhanging the streambanks helps to moderate water temperatures, which improves spawning and rearing habitat for fish. The Mainstem Issaquah Creek riparian wetlands do not play a major role in stabilizing streambanks because most of the banks have been armored.

Large wetlands provide habitat for wintering birds and seasonal habitat for non-wetland species. The large wetlands near the mouth of Mainstem Issaquah Creek (Reaches Lk_Sam02, A and B) are important concentration areas for waterfowl, including priority species such as wood duck (*Aix sponsa*), goldeneye (*Bucephala* sp.), bufflehead (*Bucephala albeola*), and hooded merganser (*Lophodytes cucullatu*).

Wetlands are protected by IMC 18.10.590 through 18.10.760. These regulations establish buffers (generally 40 to 225 feet depending on the wetland rating), which limit the types of wetland alterations that can be allowed, and require mitigation to offset adverse impacts.

4.1.2 Water Quality

Changes in land use and land cover have influenced the quality of water flowing through the Mainstem Issaquah Creek. Within the Mainstem, water quality concerns have historically included bacteria (fecal coliform), temperature, and dissolved oxygen (City of Issaquah, 2004a).

The current State Water Quality Assessment (Ecology 2004) indicates that the Mainstem does not meet state standards for: (1) dissolved oxygen (from Reach C to Reach E), and (2) fecal coliform (Reach Lk_Sam02 and Reach A to Reach E). The fecal coliform problem is being addressed through a pollution control plan with ongoing monitoring (Ecology, 2004).

The City's third Issaquah Aquatic Resources Monitoring Report, State of Our Waters (City of Issaquah, 2007), documented monitoring results from the City Aquatic Resource Monitoring Program from 1999 to 2006. The program monitors habitat and water quality conditions along the streams within the City of Issaquah. According to the report, water quality in the Issaquah

[22] Wetlands described in this report have not been field-verified. Therefore, this report should not be construed as providing a comprehensive inventory of all wetlands in shoreline jurisdiction, as additional wetlands may be present and some areas mapped as wetland may not meet the wetland criteria.

Creek basin is mixed. While the monitored conditions indicate that Issaquah Creek has been degraded somewhat by both urban and rural activities, many components of water integrity, such as temperature, dissolved oxygen, zinc, and pH, meet standards most of the time[23]. Water quality is typically good during base flow conditions, but degrades significantly during higher flow events due to high sediment loads. General findings include:

- Fecal coliform bacteria appear to be the most significant water quality issue in terms of exceeding state standards and the spatial extent of the exceedances;
- Suspended sediment concentrations are high during storm events in the Mainstem Issaquah Creek and Tibbets Creek, concentrations are high in the upper watershed and appear to decrease through the City;
- Occasional exceedances for phosphorus and zinc occur;
- Smaller streams can have low dissolved oxygen during summer base flow; and
- Decreased water quality appears to occur in areas with high density commercial land use surrounding the stream.

The Aquatic Resources Monitoring Report compared collected water quality data with water quality standards to determine a relative level of contamination. This was done by calculating the percentage of times that samples exceeded the standard at each sampling station. The survey found that water in the Mainstem Issaquah Creek almost never exceeded state standards for pH, temperature, and dissolved oxygen (1 percent or less). Phosphorus (17 to 21 percent), zinc (0 to 6 percent), and fecal coliform (34 to 51 percent) exceeded state standards more often. In all cases pollutants exceeded standards in the Mainstem's lower reaches more often than the upper and middle reaches.

4.1.3 Biological Resources

4.1.3.1 Fish and Wildlife Presence

According to the Stream Inventory (Parametrix, 2003), the Mainstem Issaquah Creek and its tributaries support a considerable variety of both native and non-native fish species. Non-native fish were primarily found in the lower 1 or 2 miles or less (Warner circa 1998 personal communication), and include species such as brown bullhead (*Ameiurus nebulosus*), black crappie (*Pomoxis nigromaculatus*), pumpkinseed sunfish (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*Micropterus dolomieu*). Native fish found below the barrier weir at the Issaquah salmon hatchery include, but are not limited to, western brook lamprey (*Lampetra richardsoni*), river lamprey (*Lampetra ayresi*), peamouth chub (*Mylocheilus caurinus*), largescale sucker (*Catostomus macrocheilus*), mountain whitefish (*Prosopium williamsoni*), and one or more species of sculpin (*Cottus* spp.).

Native salmonid species include fall Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), sockeye salmon and kokanee (*O. nerka*), winter steelhead (*O. mykiss*), and cutthroat

[23] Standard is pre-2006 Washington State water quality standard

trout (*O. clarki*). Bull trout (*Salvelinus confluentus*) use of Mainstem Issaquah Creek is unlikely and would be limited to the headwater areas (i.e., resident fish only); however, strays may occasionally occur downstream.

Artificial production at the Issaquah salmon hatchery results in annual returns of thousands of Chinook and coho salmon. Flood flows create conditions where both hatchery-origin and wild-origin salmon can pass over the weir behind the hatchery and travel into the upper watershed (WDFW 1994). Salmon nests, called redds, and migrating salmon were observed above the weir during the instream survey portion of the Stream Inventory. Normally, all Chinook and coho are retained until egg-taking goals are met. When these goals are met, the remnant portion of the hatchery returns are allowed to spawn above the hatchery in the creek mainstem, as well as major tributaries such as Fifteenmile Creek, McDonald Creek, Carey Creek, and others. Natural Chinook, coho, sockeye, and steelhead production occurs in the mainstem below the hatchery, as well as in the North and East Forks of Issaquah Creek. (Many of the coho and Chinook spawners are returns from hatchery fry or smolts.)

Chinook salmon, bull trout, and wild steelhead utilizing Issaquah Creek are currently listed as threatened species under the Endangered Species Act (ESA). Chinook salmon using Issaquah Creek are included within the Puget Sound Evolutionarily Significant Unit (ESU), bull trout are included within the Coastal-Puget Sound Distinct Population Segment (DPS), and steelhead are included within the Puget Sound DPS. Critical habitat has not been proposed or designated in Lake Sammamish or tributary streams, including Issaquah Creek, for Chinook, bull trout or steelhead at this time.

The Stream Inventory also reported that naturally produced winter steelhead have suffered a precipitous decline in recent years; annual escapements to the Mainstem Issaquah Creek basin are now so low as to be almost indeterminable. Early-entry (August-spawning) kokanee have suffered a similar fate (King County Water and Lands Division 2000). Adfluvial (lake-run) cutthroat may be increasing in numbers, but annual escapements to Mainstem Issaquah Creek are not measured. Resident cutthroat trout are nearly ubiquitous in all low- to moderate-gradient perennial streams draining to Mainstem Issaquah Creek above Lake Sammamish.

Several priority habitats have been identified along Mainstem Issaquah Creek. Priority habitats and species use within each reach are shown in Maps 7 -11 (Appendix A). These include the riparian corridor along the lower reaches from the confluence of the East Fork to the mouth, and a portion of the riparian zone from Tributary 0199 south beyond the City limits. Waterfowl concentrations have been mapped near the mouth of Mainstem Issaquah Creek, largely within Lake Sammamish State Park. Shoreline vegetation in Reaches G and H is largely undisturbed. These reaches also have several wetland communities. As a result, they are likely to provide habitat for raptors, passerine and upland game birds, mammals, and amphibians. All salmon, trout, and whitefish that occur in Mainstem Issaquah Creek are listed as priority species in WDFW's priority habitats and species (PHS) database. Issaquah Creek and its associated riparian areas function as a wildlife corridor through the Issaquah Valley.

Other examples of PHS species that might be found in the area include red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), and great horned owl (*Bubo virginianus*) for raptors; black-tailed deer (*Odocoileus hemionus*), coyote (*Canis latrans*), and black bear (*Ursus* *americanus*) (City of Issaquah 1990) for mammals; and ensatina (*Ensatina eschscholtzii*) and red-legged frogs (*Rana aurora*) for amphibians.

The City of Issaquah does not have any specific regulations to protect priority habitats or species.

4.1.3.2 Instream and Riparian Habitat Conditions

Streams are designated critical areas according to the City's Critical Areas Ordinance (CAO)[24]. Streams and riparian habitats are subject to the requirements of IMC 18.10.770 through 18.10.795. According to these regulations, all shoreline streams (Type 1) are required to have a 100-foot buffer. The CAO also regulates and restricts the type and extent of development that can occur in or adjacent to streams. Compensatory mitigation is required for all unavoidable impacts.

Riparian Vegetation and Recruitment Potential

The shoreline of Issaquah Creek is dominated by urban land cover as shown in Table 4-2 (Parametrix, 2003). Riparian vegetation consists mainly of grasses (both non-native grasses and landscaped lawns) and deciduous trees, with only 1.4 percent of the total shoreline area occupied by stands of coniferous trees (Maps 14 and 15). This is significant because conifer stands provide greater habitat value and have higher potential to contribute woody material to the stream channel as they mature.

The type and quality of the riparian cover within each reach is directly related to the ability of the stream to 'recruit' large woody debris to the stream channel. Streams that can recruit woody material from the riparian area have more diverse and higher quality habitat for salmon and other species than streams that lack LWD in the channel.

Reach A has the highest potential for wood recruitment, due primarily to well-vegetated lands along the west bank. Reach B also has fairly high wood recruitment potential with some smaller areas of good recruitment potential in reaches G and H. Reaches D, G, and H all have low to medium recruitment potential in approximately 50 percent of the adjacent riparian zone. Reaches C, E, and F have little to no LWD recruitment potential.

Table 4-2 Summary of Riparian Vegetation, Mainstem Issaquah Creek (Parametrix, 2003)

Riparian Vegetation Type[a]	Area (Acres)	Area (%)	Cover Types Associated with High Wood Recruitment Potential
Conifers, Medium Dense (CMD)	3.3	1.4	●
Conifers, Medium, Sparse (CMS)	0.1	<0.1	●
Grass (GXX)	40.2	17.1	
Deciduous Trees, Large, Dense (HLD)	1.6	0.7	●
Deciduous Trees, Medium, Dense (HMD)	45.3	19.3	●
Deciduous Trees, Medium Sparse (HMS)	1.7	0.7	

[24] IMC chapter 18.10

Riparian Vegetation Type [a]	Area (Acres)	Area (%)	Cover Types Associated with High Wood Recruitment Potential
Deciduous Trees, Small, Dense (HSD)	13.8	5.9	
Deciduous Trees, Medium Sparse (HSS)	0.7	0.3	
Mixed forest, Medium, dense (MMD)	14.3	6.1	●
Mixed forest, Medium, Sparse (MMS)	1.0	0.4	
Shrubs (XXX)	14.9	6.3	
Urban (UXX)	98.1	41.7	
Total	**235**		

[a] WDNR (1997)

Instream Conditions and USBEM Results

As part of the Stream Inventory, Parametrix (2003) surveyed the Mainstem Issaquah Creek according to USBEM guidelines (R2 Resource Consultants, 2000). The following sections provide a summary of the data that were collected.

Channel Pattern and Bed Form

The Mainstem of Issaquah Creek has floodplain channel morphology. Meandering through a relatively broad alluvial valley, the stream is low gradient and depositional, with a substrate dominated by gravel. Under natural, unconfined conditions, a stream channel of this type is significantly influenced by LWD. However, LWD currently is lacking in the stream because of adjacent land uses and lack of mature forested riparian vegetation along the stream banks.

The instream survey identified only six side channels throughout the entire sampled length of Mainstem Issaquah Creek, three of which were created as part of the Pickering Place Reach channel improvements (Reaches A and B). The lack of side channels means that there is a dearth of rearing and refuge habitat for salmon and other species during high flow regimes.

In Mainstem Issaquah Creek, most reaches are relative straight, with only two reaches (Reaches E and H) found to be more than slightly sinuous. Sinuosity is a measure of a stream’s tendency to move back and forth across the floodplain in an S-shaped pattern, over time. Channels that are highly sinuous tend to have better habitat characteristics than straight stream channels.

Physical Barriers

There are few physical barriers to fish movement in Mainstem Issaquah Creek. WDFW manages the Issaquah salmon hatchery at river mile (RM) 3 to stop all Chinook and coho salmon required for annual egg-taking goals. This weir also stops all other upstream migrating species, except during periods of high flow, when larger fish jump the nappe and pass upstream. At most other times, fish are directed into the sorting ponds; those fish not used in the salmon cultural program can then be passed upstream above the barrier weir (sockeye, steelhead, cutthroat, kokanee; excess coho and Chinook).

The left bank fishway at the hatchery water supply intake diversion dam at RM 3.5 has functioned very poorly for many years, particularly during the late summer low-flow period.

This fishway is, at times, a de facto barrier for kokanee (Pfeifer 1981, 1982, 1995; King County 2000).

In December 2007, the City was awarded a grant of $400,000 from the State Salmon Recovery Funding Board (SRFB) to improve fish passage at the intake dam. The grant, funds a first phase of the project, which covers fish passage planning and design and will result in recommendations for a suite of habitat, hatchery and harvest management actions, including an adaptive management, monitoring and research plan. Planning and design is scheduled to be completed in 2009. Assuming construction funding is allocated, a second phase would include construction.

Water Temperature

Elevated stream temperatures can pose physiological barriers to fish movement. King County Surface Water Management (SWM) provided water temperature data for two stations along Mainstem Issaquah Creek. Seven to eight percent of samples collected by King County exceeded thresholds for optimal spawning temperatures (> 57 °F [15.6 °C]), while less than one percent of samples exceeded optimal temperatures for rearing (> 75.4 °F [17.8 °C]). These poor conditions are common only during the hottest part of the year. Fair conditions occur more frequently for rearing than spawning, but 81 percent of the time, conditions are considered good for both rearing and spawning.

Fall Chinook, which enter Mainstem Issaquah Creek as early as the last week of August, and spawn from mid-September through mid-November, are most at risk from high water temperatures. According to McCullough (1999) the maximum temperature for salmonid spawning is 57 °F (15.6 °C). The King County data from Mainstem Issaquah Creek showed only two years (1997 and 1998) between January 1996 and October 2001 when stream temperature approached this threshold in early to mid-September. Much more complete temperature data (including continuous temperature data) are needed from Mainstem Issaquah Creek to evaluate warming trends, if any, and risks to salmonids in general.

Pool and Riffle Habitat

Pool frequency was found to be poor throughout all reaches of the Mainstem. This can be attributed to the loss of scour pools in meanders due to channelization and the extreme lack of LWD. Riffle substrate condition varies throughout all reaches, with substrate composition generally being good and the ebmeddedness ratings being typically fair to poor. This essentially means that there is adequate spawning material present; however, the gravels are embeddeded with fine sediment which reduces the potential for these areas to provide good spawning habitat. The percent riffles that are spawnable are relatively high; however, the overall ratio of riffles to pools within all reaches is generally below that needed to support healthy salmonid populations.

Large Woody Debris

LWD density is rated Poor for every reach in the Mainstem Issaquah Creek. This is consistent with Beechie and Sibley (1997), who reported that Mainstem Issaquah Creek had the lowest LWD density (0.05 pieces per meter) of 28 streams draining the lower west slopes of the north central Cascades. The instream survey identified only a single piece of key LWD. Pieces of MWD (i.e. LWD not meeting requirements for key pieces but still having a significant hydrologic or morphologic impact on the stream) were found in all reaches to varying degrees. In most cases, MWD had been placed as part of an enhancement project.

Bank Condition

Bank condition is assessed in terms of bank stability and bank modification. More than 80 percent of banks are stable for every reach, because of the extensive armoring that has occurred along the stream. However, significant bank instabilities are still present along the stream. Reaches B through G have Fair to Poor habitat ratings for bank modification as a result of the extensive revetments installed for flood control. Some reaches are particularly Poor, with more than 50 percent of the total bank length having undergone some form of modification.

Benthic Index of Biotic Integrity (B-IBI)

B-IBI scores are a measure of the general health of the instream invertebrate community and can be used as an indicator of overall habitat quality. The City of Issaquah maintains B-IBI monitoring at three stations along Mainstem Issaquah Creek, while King County monitors B-IBI at one station within the City limits. The data indicate that Mainstem Issaquah Creek has fewer taxa that are intolerant of disturbance compared to undisturbed streams. However, overall taxa richness remains high across all major orders except predators. According to the 2007 State of Our Waters Report (City of Issaquah), the latest B-IBI scores for the Mainstem Issaquah Creek were considered ‘Good’ at the upstream and mid-stream monitoring stations and ‘Fair’ at the downstream station.

Properly Functioning Conditions (NMFS Pathways and Indicators)

Properly Functioning Conditions (PFC) is defined as the sustained presence of natural habitat-forming processes necessary for the long-term survival of species through the full range of environmental variation (NOAA Fisheries, 1996). Indicators of PFC vary between different landscapes based on unique physiographic and geologic features. Since aquatic habitats are inherently dynamic, PFC is defined by the persistence of natural processes that maintain habitat productivity at a level sufficient to ensure long-term survival (NOAA Fisheries, 1999). The NOAA Fisheries (1996) and the USFWS (1998) identify that PFC commonly includes the following elements: water quality, habitat accessibility, the suitability of various habitat elements, channel condition and dynamics, and overall watershed conditions. Estimates in the PFC assessment discussed below are based on information collected and contained in the 2003 Stream Inventory.

Existing conditions in the Mainstem Issaquah Creek were evaluated in terms of the pathways and indicators criteria defined by the NMFS (1996). Table 4-3 summarizes the results for each stream reach in terms of ‘Properly Functioning,’ ‘At Risk’ and ‘Not Properly Functioning.’ A brief description of the indicators associated with the major pathways is also provided for each reach. For more detailed descriptions of the PFC results refer to the Stream Inventory (Parametrix, 2003).

Table 4-3 Mainstem Issaquah Creek Habitat Conditions Summary (Data are from Parametrix, 2003)

Pathway	Indicator	Reach							
		A	B	C	D	E	F	G	H
Water Quality	Temperature	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	Sediment/TSS	●	●	●	●	●	●	●	●
	Chemicals	⊙	⊙	⊙	⊙	⊙	⊙	○	○
Habitat Access	Physical Barriers	○	○	○	○	○	⊙	⊙	○
Habitat Elements	Substrate	⊙	⊙	●	●	●	●	●	●
	Large Woody Debris	●	●	●	●	●	●	●	●
	Pool Frequency	●	●	●	●	●	●	●	●
	Pool Quality	⊙	⊙	⊙	⊙	⊙	●	●	⊙
	Off-channel Habitat	⊙	●	●	⊙	⊙	●	●	●
Channel Condition and Dynamics	Bank Condition	○	○	⊙	○	●	⊙	⊙	○
	Floodplain Connectivity	⊙	⊙	●	⊙	●	●	●	●
Flow/Hydrology	Change in Peak flows	●	●	●	●	●	●	●	●
	Change in Base flows	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Watershed Condition	Road Density	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	Riparian Reserves	●	●	●	●	●	●	●	●

○ Properly Functioning

⊙ At Risk

● Not Properly Functioning

4.1.3.3 Summary of Habitat Conditions by Reach

Reach A

The most common problems in lower Mainstem Issaquah Creek are exhibited in this reach. Excessive sand and fines have degraded or embedded riffles that are commonly chosen by salmon for spawning. The streambed sediment matrix is composed largely of very small gravel and sand, and is highly unstable during moderate and higher flows. Salmon spawning nests (called redds) constructed during the low-flow period in the late fall are highly vulnerable to scour. High suspended sediment levels during freshets have a high potential of infiltrating salmon redds that are constructed, sharply reducing egg-to-fry survival. Pools and back-eddies contain deep, at times very soft and unconsolidated fine sand and silt.

LWD needed to form deep pools is generally lacking, thus reducing holding habitat for kokanee and Chinook in the late summer, and rearing habitat for several salmonid species year-round. LWD that has been placed along the right bank for restoration purposes is having limited effectiveness. Most of the tree stems placed parallel to the bank near the bottom of this reach do not have significantly deep pools under or downstream of them.

Reach B

As in most of the other reaches, chronic high levels of total suspended sediment (TSS) degrade the quality of spawning gravel and impact incubating eggs and alevins. A general lack of LWD and resultant instream diversity and pools limits rearing habitat for species such as coho salmon and steelhead and cutthroat trout. Recent restoration efforts upstream of the North Fork have added limited refuge and rearing habitat by creation of side channels, but overall this feature is still generally lacking.

Reach C

Suspended sediment during storm freshets, lack of LWD, lack of pool habitat, and a lack of refuge/rearing habitat (side channels, etc.) are problems in this reach, as in much of the rest of lower Mainstem Issaquah Creek. Additional problems in this reach are increasing fines in the substrate, and a confined, incised channel, preventing normal flooding and floodplain connectivity. The combination of poor substrate composition and channel confinement likely create conditions that favor scour of salmon and trout redds, destroying incubating eggs or alevins. The lack of LWD and deep pools in the urban area create a dearth of escape cover, making spawning salmon more vulnerable to predators of various kinds.

Reach D

Problems in this reach are nearly identical to those of Reach C immediately downstream. An even higher percentage of the substrate was judged to be polluted with fine sediment in this reach. A small wood debris jam composed of medium-sized pieces occurs a short distance below the mouth of the East Fork. This jam has created local instream diversity, but its stability and longevity are questionable. Most of the larger MWD pieces were part of an earlier restoration effort but are not providing much pool or refuge habitat. An extensive reach of the left bank is actively eroding at this location, contributing fines to downstream habitat.

Reach E

All of the limitations noted for Reach C also occur in this reach. In addition, Reach E has a narrow to non-existent riparian zone that cannot contribute large wood in the future, and riprap bank protection and landscaping have locked the stream into its present configuration and limitations.

Reach F

Fish use of this reach is heavily influenced by operations at the WDFW salmon hatchery. The fish diversion rack, or weir, is located within this reach. Depending on spawner collection needs, salmon may or may not be passed upstream beyond this point. Salmon and trout species present, spawning, and rearing below the weir include fall Chinook, coho, sockeye, and kokanee salmon, and, historically, steelhead. Most coho and Chinook are diverted at the rack for cultural purposes. Most if not all sockeye that reach the weir are passed upstream. Most adfluvial cutthroat spawning is believed to occur upstream of the hatchery. Spawning substrate is very poor just above the hatchery weir due to accumulation of sand and silt, and does not improve substantially until approximately the Clark Street bridge.

Reach F is probably the most degraded and limiting of the roughly 4.6 miles of Mainstem Issaquah Creek habitat within the City. Of surveyed habitat attributes, seven are deemed Not Properly Functioning, and an additional three are felt to be At Risk. Problems in this reach that are in addition to those in Reach C include a complete lack of functional pools, and wild, native fish passage delays or problems at the hatchery weir.

Reach G

Instream conditions in this reach are similar to those of Reach F, but bank riparian vegetation is somewhat better than in Reach F. Fish passage at the antiquated and poorly functioning diversion dam fishway is particularly problematic during the late summer low-flow period. The City has received a grant from SRFB for planning and design of improvements at the Issaquah Creek hatchery intake dam to improve fish passage (refer to section 4.1.3.2 for a more detailed discussion of the project).

Reach H

Habitat limitations in this reach include excessive fines and sand fractions in spawning riffles, chronic turbidity (suspended sediment) after rainfall, a general lack of functional LWD, scarce deep pools, and almost no off-channel habitat for juvenile salmon rearing or refuge. Features that show improvement from this point upstream include bank condition, substrate quality, LWD presence, pool habitat, and floodplain connection.

Mainstem Issaquah Creek in Reach Lk_Sam02

The Stream Inventory (Parametrix, 2003) did not evaluate conditions within the creek within the State Park. In general, stream conditions within the state park are better than throughout the rest of the City because the shorelines are undeveloped and less modified. However, problems do persist. In the past, much of the park was used for agriculture. Native woody vegetation was cleared and these cleared areas, which include the shorelines of the creek, have become dominated by invasive species, particularly reed canarygrass and blackberries (Watershed Company, 2005). These invasive plants are detrimental to the overall functioning of the creek because they inhibit and compete with native vegetation that provides shade, cover from predators, LWD, and food sources for native wildlife. Conditions of and around Issaquah Creek within Reach Lk_Sam02 are discussed further in section 4.3, Lake Sammamish.

4.1.4 Built Environment

4.1.4.1 Existing Land Use, Comprehensive Plan Land Use, and Zoning

The land use pattern within the City's shoreline planning area along the Mainstem Issaquah Creek has not dramatically changed from the pattern described in the 2003 Stream Inventory (Parametrix, 2003). New commercial and residential developments and redevelopment projects have occurred, but the basic land use pattern in the shoreline has not significantly changed.

The creek passes through a diverse urban setting from Lake Sammamish State Park through Issaquah's central business district (CBD), and then through residential developments and publicly owned open space to the south. Maps 19 - 21 (Appendix A) show zoning along the

Mainstem shoreline reaches. The City's Comprehensive Plan land use designations are shown in Map 17 (Appendix A).

Existing land use patterns are described based on King County assessors parcel data. In general low-density residential development and vacant land are the two dominant land uses in terms of area, 30 and 34 percent, respectively. Approximately 9 percent of the shoreline is categorized as open space. Commercial and multi-family land uses make up 7 percent each. Lands dedicated to transportation comprise approximately 10 percent of the shoreline planning area.

The lower reaches of the Mainstem shoreline contain a high percentage of commercial property. Approximately 20 percent of the shoreline planning area in Reach A and 46 percent in Reach C are commercial. The planning area in these reaches is dominated by the City's CBD and is highly urbanized.

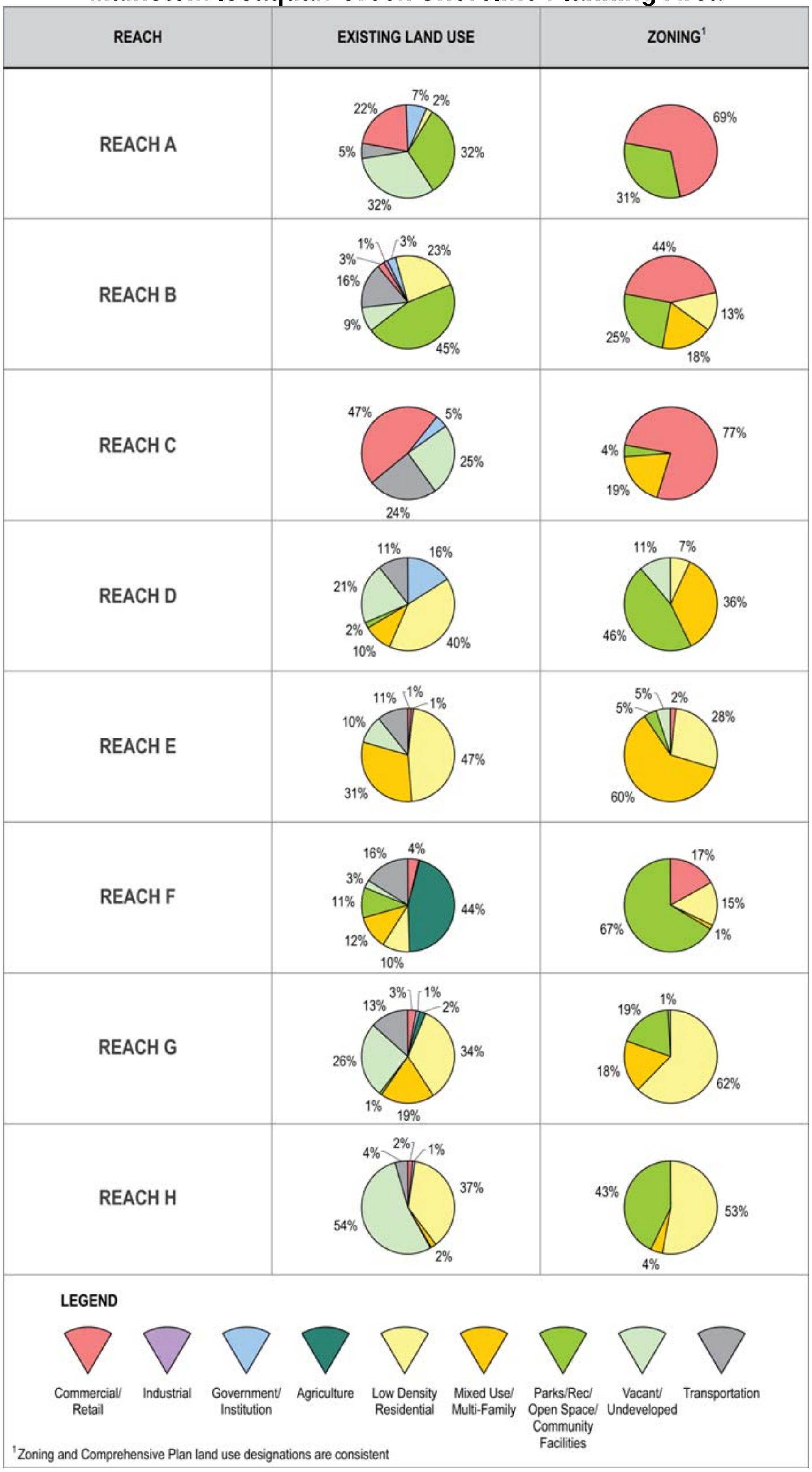
With the exception of Reach F, which includes the hatchery and other commercial property, land use along the remaining reaches is predominantly residential. The density of residential development diminishes as one moves upstream. Reaches G and H contain 80 percent of the low-density residential areas in the shorelines.

Zoning in the shoreline planning area along the Mainstem Issaquah Creek is largely consistent with the City's Comprehensive Plan land use designations. Approximately one-third of the shorelands are zoned low-density residential and one-third zoned for parks, recreation, and open space (35 and 32 percent respectively). The remaining third is divided between commercial/retail (17 percent) and vacant/undeveloped (14 percent). Nearly all of the commercial/retail zoning in the Mainstem shorelands (97 percent) is located within the lower reaches (A, B, and C), which coincides with the City's CBD. The proportion of low-density residential zoning in the shorelines increases in the upper reaches. Approximately 86 percent of low-density residential zoning in the Mainstem shorelines is located in Reaches G and H.

Figure 4-2 shows the proportions of current land use and zoning (comprehensive plan land use designations are consistent with zoning) for lands in each Mainstem shoreline reach. The data for zoning exclude roadways. Roads are included in the existing land use data.

The Department of Ecology maintains a statewide GIS database of facilities with suspected or confirmed contaminated sites, and facilities with the potential to introduce contamination into the environment. The database was reviewed to identify any known sites in the shoreline planning area. There are six sites listed. Of the six, three are listed as inactive. The three active sites include the WDFW Fish Hatchery (Reach F) and the Issaquah Pool (Reach G). The remaining site, a Federal Express facility (Reach B) is listed as a hazardous waste generator. These facilities are listed because of requirement for facilities that store a hazardous chemical on site to file annual reports with Ecology. The FedEx site is defined as a facility that generates any quantity of a dangerous waste. No other toxic or hazardous waste sites were identified in the Mainstem Issaquah Creek shoreline.

Figure 4-2 Percentages of Existing, Allowed and Planned Land Use by Reach in the Mainstem Issaquah Creek Shoreline Planning Area



4.1.4.2 Water-oriented Uses

One of the three main goals of the Shoreline Management Act is to encourage water-dependent uses. The Act establishes a preference for uses that are consistent with control of pollution and prevention of damage to the natural environment, or are unique to or dependent upon use of the states' shorelines[25].

Water-oriented uses include those that are water-dependent, water-related or water-enjoyment. Table 4-4 presents the Guidelines' definition of these terms and examples of each. Under the Guidelines, single family residences, while not considered water-oriented uses, are given preference over other uses in the shoreline. The SMA states that where alterations to natural conditions are allowed, priority shall be given to single family residences[26]. The Act states further that all permitted uses in the shoreline of the state shall be designed and conducted in a manner to minimize, insofar as is practical, any resultant damage to the ecology and environment of the shoreline area and any interference with the public's use of the water.

Water-dependent and water-related uses in the Mainstem Issaquah Creek shoreline planning area are limited and future demand for water-oriented uses (other than parks) is expected to be relatively low. The WDFW Issaquah fish hatchery is the only use in the Mainstem shoreline that would be considered water-related. A review of King County assessors data indicates that there are only two properties designated as industrial and approximately 28 properties (17 of which are in Reach C) designated as commercial or retail within or partially within the Mainstem shoreline. None of these properties appears to be water-dependent or -related.

Table 4-4 Water-oriented Uses

Shoreline Use Type	Definition	Examples
Water-dependent	A use or portion of a use which cannot exist in a location that is not adjacent to the water and which is dependent on the water by reason of the intrinsic nature of its operations.	▪ Shipyard dry docks and other commercial docks ▪ Marinas ▪ Ferry terminal ▪ Cargo terminal loading area ▪ Barge loading ▪ Research vessel homeport ▪ Log booming
Water-related	A use or portion of a use which is not intrinsically dependent on a waterfront location but whose economic vitality is dependent upon a waterfront location because: a) The use has a functional requirement for a waterfront location such as the arrival or shipment of materials by water or the need for large quantities of water; or (b) The use provides a necessary service supportive of the water-dependent uses and the proximity of the use to its customers makes its services less expensive and/or more convenient.	▪ Vessel parts and equipment fabrication ▪ Container ship yards ▪ Fish hatchery/hatchery support services ▪ Seafood processing plants ▪ Warehousing of goods requiring barges ▪ Assembly of water transported parts

[25] RCW 90.58.020

[26] RCW 90.58.020

Shoreline Use Type	Definition	Examples
Water-enjoyment	A recreational use or other use that facilitates public access to the shoreline as a primary characteristic of the use; or a use that provides for recreational use or aesthetic enjoyment of the shoreline for a substantial number of people as a general characteristic of the use and which through location, design, and operation ensures the public's ability to enjoy the physical and aesthetic qualities of the shoreline. In order to qualify as a water-enjoyment use, the use must be open to the general public and the shoreline-oriented space within the project must be devoted to the specific aspects of the use that fosters shoreline enjoyment (WAC 173-26-020).	▪ Restaurants ▪ Museums ▪ Resorts and other private parks ▪ Mixed-use projects

There are limited opportunities for these types of uses in the Mainstem shoreline planning area because the creek is too small to support significant water transport; marina development; or commercial or industrial operations. Also, the abundance of single family residences (which is considered a preferred use under SMA), retail areas and open space is incompatible with many large-scale uses such as those shown as examples in Table 4-4.

There may be some uses in the shoreline that would qualify as water-enjoyment. These would include the public parks and open spaces described in section 4.1.4.4 and could include restaurants or other publicly accessible businesses that offer visual or physical access to the creek. There is sizeable areas of commercial zoning along the Mainstem Issaquah Creek that could be developed to take advantage of their creek side location.

4.1.4.3 Impervious Areas

Impervious areas were analyzed based on the City's impervious areas GIS layer (see Maps 24 – 28 in Appendix A). Impervious areas include roadways, buildings and other paved surfaces (such as driveways and parking lots) that prevent the natural entry of water into the soil. The quantity of impervious surface is a key factor in changing the rainfall to runoff relationship. Impervious surfaces affect natural infiltration, create more stormwater runoff, increase the rate of runoff and alter runoff timing. Table 4-5 shows the total impervious area and percent of impervious area for each reach within the Mainstem Issaquah Creek shoreline planning area. The table also shows the proportions of roads and buildings in the total impervious area.

Table 4-5 Impervious Surface in the Mainstem Issaquah Creek Shoreline Planning Area

Reach	Total Acres	Impervious Area (Acres)	Percent Impervious	Roadway % of Total Impervious areas	Building % of Total Impervious Areas
A	26	3	13	46	10
B	31	2	7	62	22
C	21	10	46	20	24
D	21	4	18	38	40
E	26	8	32	20	54
F	7	4	61	22	25
G	31	8	26	46	28
H	117	7	6	39	37

Source: City of Issaquah GIS data (2006)

In general, the percentage of impervious area is an indicator of development density and intensity. As expected, the lower reaches, which contain the City's CBD, have high percentages of impervious area. However, all of the reaches have levels of impervious surface sufficient to change stream channel morphology and alter natural hydrological process (Booth et al., 2002).

4.1.4.4 Parks, Open Space, and Public Access

A primary goal of the SMP is to provide for public access to shorelines. Several City parks offer public access to the Mainstem Issaquah Creek. The City's Parks, Recreation, Trails and Open Space Plan (2003) describes the parks, open spaces, and trails in the City. Approximately 9 percent (24 acres) of the Mainstem shoreline planning area are comprised of parks or designated open spaces.

Major public parks and open spaces along Mainstem Issaquah Creek include (from north to south) the Pickering Farm; Emily Darst Park; Cybil Madeline Park; Issaquah Creek Park; Gibson Park and the Salmon Hatchery; Mine Hill Park; and Squak Valley Park North and South, the South Issaquah Creek Greenway, and the Foothills Open Space (Map 9 and Maps 19 – 22 in Appendix A). Park and open space acquisition is an ongoing process. The City has recently acquired additional park lands that may not be represented in the currently available maps.

Many of the publicly owned properties along the Mainstem are currently undeveloped. The Squak Valley Parks were acquired in 1988 and 2000.Squak Valley Park South is currently (2008) under development. An active recreational area adjacent to the Issaquah-Hobart Road will be developed. The wetland lower bench area adjacent to Issaquah Creek will be preserved. Squak Valley Park North is expected to be preserved as a natural open space area. There are preliminary plans to breach levees along Issaquah Creek to re-connect with the creek with the floodplain and adjacent wetlands..

Emily Darst, Cybil Madeline, and Issaquah Creek parks are currently undeveloped. The City's Park, Recreation, Trails, and Open Space Plan (2003) lists planning for the development of these properties as a long-term goal, with a timeframe of 2003 - 2022.

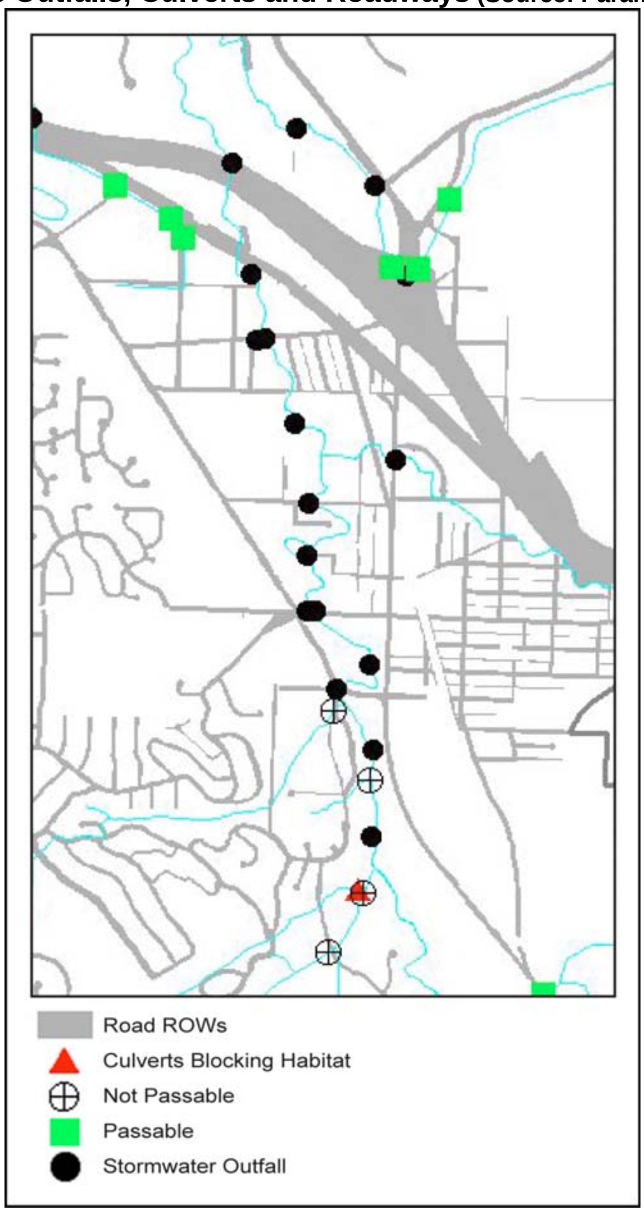
Several recreational trails offer access to the Mainstem as well. These include the Pickering Trail and the Gilman Boulevard Greenway. Other publicly owned facilities that are located adjacent to the Mainstem Issaquah Creek include the Issaquah Valley Elementary Administration property and the parks/facilities shop. The latter site is identified in the parks plan as a property to become part of the Issaquah Creek and Cybil Madeline park site.

4.1.4.5 Transportation and Utilities

The most significant transportation feature in the Mainstem Issaquah Creek area is I-90, which crosses the creek in Reach B. Transportation uses, of which I-90 makes up the majority, comprise 16 percent (4.9 acres) of Reach B. There are several other bridges that cross the Mainstem. The 2003 Stream Inventory reported a total of seven bridges that span Mainstem Issaquah Creek, starting with three major structures at 56th Street and I-90 eastbound and westbound. Farther upstream in the middle of the City, smaller bridges on residential streets, including Gilman Street, Juniper Street, Dogwood Street, Sunset Way, and Clark Street, cross the stream. In the low-density area of south Issaquah, only the residential collector Sycamore Street crosses the stream.

The 2003 Stream Inventory also reported the presence of stormwater outfalls and culverts along the Mainstem and its tributaries. At the time, a comprehensive map of culvert locations was not available, but field staff identified and assessed culverts during field surveys. The Stream Inventory only includes the information on Mainstem shorelines. The 2003 Inventory found 13 stormwater outfalls in Reach B through G. No outfalls were reported for Reaches A and H. Lake Sammamish State Park was not inventoried. Figure 4-3 shows outfalls, culverts, and major road crossings within the shoreline planning area (See Map 29 in Appendix A).

Figure 4-3 Outfalls, Culverts and Roadways **(Source: Parametrix, 2003)**



4.1.4.6 Historic and Cultural Resources

The Mainstem Issaquah Creek, as well as the other shoreline areas within the City of Issaquah, are part of the usual and accustomed fishing area of the Muckleshoot Indian Tribe and the Snoqualmie Indian Tribe per the Point Elliot Treaty. The creek has served as a cultural resource for the Muckleshoot, Snoqualmie, Sammamish and other tribes who have harvested fish, game and plant species in this area for generations.

Ethnographically, the Sammamish people are linked to other Duwamish-speaking bands. Together, these bands are known as the "Lake People" due to their association with the major lakes of WRIA 8, including Lake Sammamish as well as Lake Washington and Lake Union. The Sammamish people were reported to live in villages along the Sammamish River, the Lake Sammamish shoreline, and along the eastern shoreline of Lake Washington, and were closely tied to the inland Snoqualmie, with whom intermarriage was common (Jones and Stokes, 2005; Historical Research Associates, Inc. 1997).

Cultural resources reports prepared for the Issaquah vicinity document a history of Sammamish villages grouped at the southern end of Lake Sammamish, within present day Lake Sammamish State Park (Reach Lk_Sam02). These permanent villages were made up of cedar plank houses, which typically housed three to four housing groups, and were predominantly occupied within winter months.

The area around the mouth of Mainstem Issaquah Creek, at the south end of Lake Sammamish (presently Lake Sammamish State Park), was once a gathering place for Native Americans, where they prepared for winter and celebrated their potlatch (winter festival). In the spring, the Sammamish, Muckleshoot, and Snoqualmie peoples' annual hunting-fishing-gathering activities would begin, with salmon, trout, clams, terrestrial mammals, berries, and plants the primary targeted food sources (Compliance Archaeology, L.L.C. 2003, Historical Research Associates, Inc. 1997).

Currently, the Muckleshoot Indian Tribe, both within the Muckleshoot Reservation (within and adjacent to the city of Auburn, King County) and in the general Puget Sound area, is one of Washington State's larger Tribes. Under established treaty rights, the Muckleshoot Tribe annually harvests 50 percent of the total catch of the Lake Washington and Lake Sammamish sockeye salmon fishery. This population of sockeye relies on habitat provided, in part, by Issaquah's shorelines and watersheds, as well as the surrounding area. Due to the importance of this resource, and other traditional resources, the Muckleshoot Indian Tribe continues to play an active role in the maintenance and protection of the City's shorelines (Muckleshoot Indian Tribe, 2008).

Euroamerican settlement of the Issaquah area began in 1863. At the time, the area was commonly referred to as Squak Valley. Settlement was driven by the discovery of coal at the nearby Squak Mountain. Along with coal mining, timber harvest, milling operations, and hop farming were the primary economic activities during the period of early settlement. Euroamerican settlement continued to grow in the Issaquah vicinity as transportation routes, including water transportation (connecting Lake Sammamish to Lake Washington) and rail transportation, were developed.

The existing Issaquah Shoreline Master Program provides a general goal to identify, restore and preserve those features of historical/cultural, scientific, and educational value for use by the public. The City of Issaquah Comprehensive Plan (2001) also addresses historic preservation. The Comprehensive Plan establishes a goal to maintain, preserve, and enhance the city's historic, cultural, and archeological resources to provide a sense of local identity and history to the community.

The Washington State Department of Archeology and Historic Preservation (DAHP) maintains a database system which catalogs sites that have been inventoried by State Archeologists, cultural survey reports prepared for specific areas during project specific planning efforts, as well as sites that are protected by Washington's Historic Register (WHR) and the National Register of Historic Places (NRHP). A search of the database indicated that there are no state or federally registered sites within the shoreline planning area, but there is one inventoried site, the Pickering Farm (KI-142) located at 21809 SE 56th Street. The farm area is located immediately to the southeast of the State Park adjacent to Issaquah Creek. The property includes five structures, including a hay barn, cow barn / horse stables, and the residence. The hay barn was constructed in 1890, with the addition of the cow barn in 1906. The farm and structures are registered for their local significance to agriculture, architecture, and exploration/settlement. WHR and NRHP listing occurred in 1983. No other sites or structures within the Issaquah Creek planning area are listed under the WHR or NRHP.

The U.S. Army Corps of Engineers, Seattle District prepared a cultural resources investigation report for the Issaquah Creek Section 2006 Restoration Project and the Squak Valley Environmental Restoration Project on Issaquah Creek planning efforts (USACE, 2004a and 2004b). The existing dam structure associated with the WDFW fish Hatchery was determined to be eligible for potential historic register listing. The study also identified a historic railroad bed within the area of potential effects (APE), as well as several structures that were proposed for demolition.

Several cultural resources investigations have been conducted for recent projects in the City (Jones and Stokes, 2005 and Archeological Investigations Northwest, Inc.,1999). These reports collectively identify several objects and/or structures that meet minimal historic criteria per the WHR and the NRHP. However, all documented objects and/or structures were determined to be of minimal historic significance, and as such were not recommended for designation as historically significant or other protection.

These cultural resources reports note that within Issaquah's shoreline areas, potential for encountering culturally significant artifacts is low to moderate with limited areas noted as high. Areas within the shoreline planning area, specifically along the Lake Sammamish shoreline, were noted for having a moderate degree of potential due to ethnographic use by the Sammamish and other area tribes.

4.1.4.7 Shoreline Modifications

Shoreline modification refers to structural changes to a shorelines' natural bank. Examples include shoreline armoring (bulkheads, riprap, etc.), overwater structures (docks and piers), and dredging and filling (Figure 4-4). The Stream Inventory assessed the level of shoreline modification as a component of bank condition (Parametrix, 2003).

Figure 4-4 Typical Shoreline Armoring

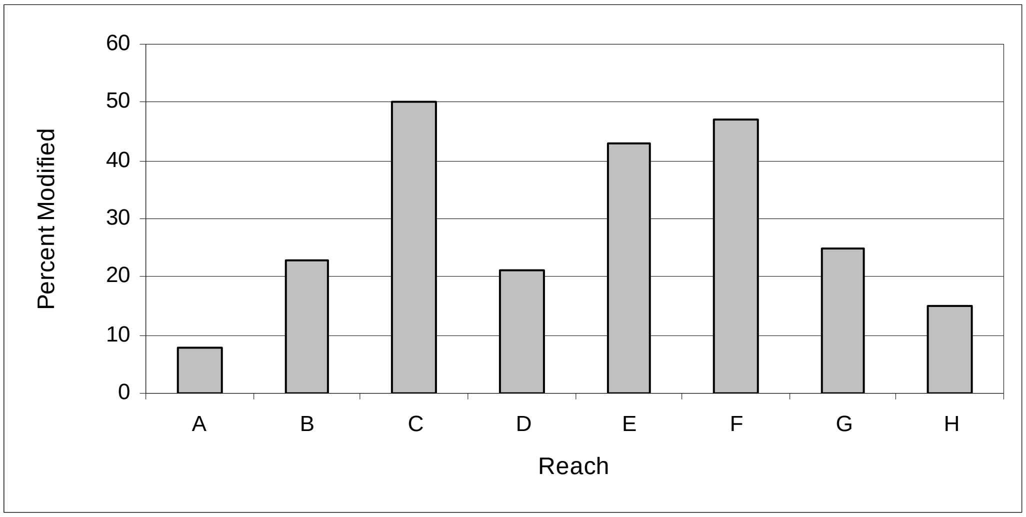
Source: Parametrix, 2003

Modification was continuously measured and recorded along both banks of the creek. The types of modification included dikes, levees, and berms; revetments; bulkheads; bridge footings; dams[27]; and culverts.

The Inventory found that the shoreline of the Mainstem Issaquah Creek is extensively armored, particularly through the CBD area in Reach C (Parametrix, 2003). Figure 4-5 below presents the percentages of shoreline modification for each reach. The inventory reported that nearly all of the modifications along the creek were riprap revetments. The exceptions were bridge footings and the weir at the fish hatchery. The general pattern of shoreline modifications within Mainstem Issaquah Creek has not changed dramatically since the 2003 inventory was completed.

[27] Weirs are classified as dams.

Figure 4-5 Mainstem Issaquah Creek Percent Bank Modification by Reach



Source: Parametrix, 2003

4.2 East Fork Issaquah Creek

The East Fork of Issaquah Creek originates on West Tiger Mountain and flows approximately 7.3 miles to its confluence with Mainstem Issaquah Creek at RM 2.15 (Reach D) (Parametrix, 2003). The East Fork drains 9.5 square miles, with 1.6 of those square miles in the City (City of Issaquah, 2004a).

Alterations in land use and land cover along the East Fork are similar to those described for the Mainstem Issaquah Creek. Direct alterations to the East Fork appear to be more extensive due to the past use of the channel as a log flume, construction associated with I-90 and the Sunset Interchange, and urban development (Parametrix, 2003).

4.2.1 Critical Areas

Critical area regulations and protections referenced in Section 4.1.1 for the Mainstem Issaquah Creek also apply to the critical areas in the East Fork shoreline planning area.

4.2.1.1 Aquifer Recharge Areas

Like the Mainstem, the East Fork flows across the LIV aquifer within the Issaquah Valley Groundwater Management Area. However, the geology in the vicinity of the East Fork is very different than that of the Mainstem alluvial valley due to the presence of coarse glacial outwash sediments and a significant change in slope at the edge of the upland plateau. These features combine to allow for significant aquifer recharge along the east edge of the East Fork shoreline planning area. Mapped CARAs along the East Fork include both Class I and III.

Near the East Fork, the aquifer is mapped as moderately to highly susceptible to groundwater contamination (King County, 2005a). In general, susceptibility appears to decrease from upstream to downstream (Table 4-6).

Table 4-6 Summary of Critical Areas and Water Quality - East Fork Issaquah Creek

Reach	Geologic Hazard	Aquifer Susceptibility	Floodplain Width (ft)	2004 Water Quality Assessment (Category 4 or 5)[28]
X	No	Low	60	No
Y	Erosion and Landslide	Low and Medium	70	No
Z	Erosion and Landslide	Medium	No data	No
ZZ	No	Medium	No data	No
Sources:	King County GIS	Issaquah GIS	FEMA mapping	Ecology 303(d) list

4.2.1.2 Flood Hazard Areas

A 100-year floodplain (1 percent annual chance of flooding) has been mapped along the East Fork, at least as far upstream as the first I-90 crossing (Map 3). This East Fork floodplain is significantly narrower than the floodplain of the Mainstem due to the smaller contributing area (9.5 square miles compared to 61 square miles), and the relatively modified and confined nature of the stream channel.

As noted in the 2003 Stream Inventory (Parametrix, 2003) and the Stormwater Management Plan (City of Issaquah, 2004a), hydrologic and land cover modifications have occurred throughout the watershed, so the scale of flooding in the East Fork is similar to that of the Mainstem Issaquah Creek.

4.2.1.3 Geologically Hazardous Areas

Mapped geologically hazardous areas along the East Fork include erosion and landslide hazards (Map 6). These areas are concentrated along the dissected steep hillside along the north side of the East Fork (Reaches Y, Z, and ZZ). Erosion hazards are mapped along the entire hillside, and landslide hazards are mapped in limited areas with steeper slopes.

Channel Migration Zones

As with the Mainstem, no formal channel migration study has been performed for the East Fork. Prior to substantial channel modifications, it appears reasonable that the channel migrated over most of the relatively narrow alluvial valley. However, the current migration zone appears to be significantly reduced by the presence of I-90 on the north side of the channel as well as surrounding urban development.

Downstream of I-90, the high degree of bank modification (around 50 percent) and significant urban development indicate that channel migration would be very limited. Migration can likely occur in this reach, but only in the portion of the valley north of I-90 (Parametrix, 2003).

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[28] Category 5 waters are waters for which at least one characteristic or designated use is impaired, as evidenced by failure to attain the applicable water quality standard for one or more pollutants. Category 4a waters show that a characteristic use is impaired by a pollutant, but a Total Maximum Daily Load (TMDL) addressing that impairment has already been developed and been approved by the US EPA.

4.2.1.4 Wetlands

Potential wetland locations along the East Fork Issaquah Creek are shown in Maps 7 - 11[29] (Appendix A). Fourteen individual wetlands were identified in the Stream Inventory along the shoreline, but the total wetland area is only approximately 3.2 acres (Parametrix, 2003). The small acreage is due to the urban character of the stream valley. All of the identified wetlands occur within Reach Y with the exception of one wetland that occurs in both Reach X of East Fork Issaquah Creek and Reach D of Mainstem Issaquah Creek.

The geomorphic setting for all wetlands within each reach is primarily riverine, medium-gradient with the exception of three wetlands which are depressional groundwater slope. The water source for all wetlands within each reach is via lateral transport or a combination of lateral transport and groundwater seepage. The hydrodynamics or flow regime for wetlands along the East Fork Issaquah Creek is medium gradient unidirectional flow with the exception of the depressional wetlands, which exhibit some vertical fluctuation due to groundwater influences. Wetlands are a mixture of palustrine emergent (PEM), palustrine forested (PFO), and palustrine scrub/shrub (PSS) habitats, although palustrine forested wetlands tend to dominate.

Because most of the wetlands are small (less than 0.25 acre), they have limited capacity to store runoff or filter sediments. The proximity to I-90 reduces habitat quality for some species because of noise and light from automobiles.

4.2.2 Water Quality

Changes in land use and land cover have influenced changes in the quality of water flowing through the East Fork. These changes cover a broad spectrum of parameters, but our current understanding of water quality in the East Fork is incomplete (City of Issaquah, 2004a). Known significant potential sources of water quality degradation are present in the drainage area (e.g., I-90), so it is reasonable to assume that water quality in the creek has been impaired. However, there are no Category 4 or 5 listings in the 2004 Ecology Water Quality Assessment.

The Aquatic Resources Monitoring Report, State of Our Waters (City of Issaquah, 2007), also reported on water quality parameters for the East Fork Issaquah Creek. Sampling data were drawn from two sampling stations, one in the upper reaches and one on the lower. As described previously for the Mainstem, the Report compared collected water quality data to water quality standards to determine a relative level of contamination. This was done by calculating the percentage of times that a sample exceeded the standard at each sampling station.

Water in the East Fork Issaquah Creek almost never exceeded state standards for pH, temperature, and dissolved oxygen (1 percent or less). Phosphorus (12 to 19 percent), zinc (6 to 4 percent), and fecal coliform (39 to 38 percent) exceeded state standards more often. Unlike the Mainstem, water samples in the upstream reaches of East Fork were found to be contaminated

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[29] Wetlands described in this report have not been field-verified. Therefore, this report should not be construed as providing a comprehensive inventory of all wetlands in shoreline jurisdiction, as additional wetlands may be present and some areas mapped as wetland may not meet the wetland criteria.

more often than water in the lower reaches. This is likely the result of the upper reaches' proximity to I-90 and the Freeway's runoff potential.

4.2.3 Biological Resources

4.2.3.1 Fish and Wildlife Presence

According to the 2003 Stream Inventory, fish use of the East Fork Issaquah Creek consists of Chinook, sockeye, coho, and kokanee salmon, steelhead, and cutthroat trout. Brook lamprey and sculpin are also likely present in the East Fork. Urban development, changes in the hydrologic regime, and resultant high erosion rates in the basin (King County SWM 1991) have severely degraded instream habitat, and natural production of these species is now very low (coho, cutthroat) or possibly non-existent in most years (Chinook, steelhead).

No priority habitats were identified along the East Fork Issaquah Creek. This may be due to the stream's proximity to urban developments and I-90, which limits the potential habitat value for wildlife. However, all salmon and trout that use the East Fork are listed as priority species on the PHS list (WDFW, 2007).

The upper reaches of the East Fork Issaquah Creek outside the City limits are within designated Urban Natural Open Spaces (UNOS). These areas provide habitat connectivity with the Tiger Mountain State Forest, Lake Tradition, and Round Lake. These connected large habitat areas are likely to support large mammals (e.g., black-tailed deer and coyote) as well as smaller mammals (e.g., raccoon [*Procyon lotor*], opossum [*Didelphis marsupialis*], striped skunk, and various shrews and voles). Raptors (red-tailed hawk, sharp-shinned hawk [*Accipiter striatus*]) and passerine birds are often seen taking advantage of habitat along freeways.

4.2.3.2 Instream and Riparian Habitat Conditions

Riparian Vegetation

The shoreline of the East Fork of Issaquah Creek is dominated (68 percent) by urban cover types (Table 4-7) (Parametrix, 2003). Of the vegetated area, 16.6 percent is composed of dense but small stands of mixed coniferous/deciduous forest of medium size. Approximately 7.6 percent of the shoreline is vegetated with grasses, including non-native grasses and landscaped yards. Stands of deciduous trees amount to only 5.6 percent of the total shoreline. Stands of coniferous trees and shrubs occupy small areas (approximately 2.0 acres in total), and are unlikely to provide significant riparian habitat. Reach Z has the best riparian cover of any of the East Fork reaches, but riparian conditions are not properly functioning in all reaches.

Table 4-7 Summary of Riparian Vegetation, East Fork (Parametrix, 2003)

Riparian Vegetation Type [a]	Area (Acres)	Area (%)	Cover Types Associated with High Wood Recruitment Potential
Conifers, Medium Dense (CMD)	1.0	1.1	●
Grass (GXX)	6.7	7.6	
Deciduous Trees, Medium, Dense (HMD)	4.7	5.3	●
Deciduous Trees, Medium Sparse (HMS)	0.3	0.3	
Mixed forest, Medium, dense (MMD)	14.6	16.6	●
Shrubs (XXX)	0.9	1.0	
Urban (UXX)	60	68	
Total	**88.2**	**100**	

[a] WDNR (1997)

Instream Conditions and USBEM Results

Parametrix (2003) reported instream conditions for the East Fork according to USBEM guidelines (R2 Resource Consultants, 2000). The following sections summarize the Stream Inventory results.

Channel Pattern and Bed Form

Historically, the portion of the East Fork near its confluence with Mainstem Issaquah Creek was an alluvial fan that transitioned to a transport-dominated stream channel with high stream power and moderate gradient farther upstream. However, development has led to channelization of the stream within City limits, and the stream now has the same transport-dominated morphology along all the sampled reaches.

The East Fork is slightly sinuous in Reaches X and Y and moderately sinuous in Reach Z. The lack of sinuosity is due to urbanization and railroad and highway construction that have occurred along the stream. However, much of the stream has well-defined pool/riffle or step/pool morphology, which provide quality habitat for fish. The instream survey identified only two side channels along the East Fork, both of which were in Reach Z (See Map 11 in Appendix A).

Physical Barriers

The instream survey conducted as part of the Stream Inventory identified no physical passage barriers along the East Fork (Parametrix, 2003). Reach Y contains a series of five weirs, although none appear completely impassable to salmonids.

Water Quality

King County SWM is not monitoring water quality on the East Fork of Issaquah Creek. According to the latest State of Our Waters Report (2007), the East Fork Issaquah Creek did not exceed state standards during monitoring. For more detailed discussion of water quality refer to section 4.2.2.

Recruitment Potential

Much of the riparian corridor in Reach Z had a high wood recruitment potential, which may be due to the Conservancy designation along the southern bank. Urbanization, including dense residential development, has reduced the recruitment potential of the riparian corridor along Reaches X and Y. Although riparian vegetation is present within a short distance (< 25 feet) of the stream, these reaches no longer support a riparian corridor as wide as that which would occur under natural (i.e., unconfined) conditions.

Pool and Riffle Habitat

Pool frequency was found to be Poor for all reaches. Spawning riffles and substrate composition within Reaches X and Y are primarily rated as Good as they are dominated by gravel and cobble substrates. However, the quality of substrate within Reaches X and Y to has been degraded by the deposition of fine materials (silt/sand) resulting in approximately 55 percent of the riffle areas being spawnable. The higher stream gradient within Reach Z has resulted in a higher riffle percentage than the other reaches; however, the substrate composition is primarily cobble, which has reduced the spawnability of riffles within this reach to less than 50 percent. Riffle habitat dominates all reaches within the East Fork Issaquah Creek with an estimated 65 percent being riffle habitat. Pool habitat is infrequent and replaced by other habitats such as glides and runs. The pool/riffle ratio is well below that for a similarly sized stream in an undisturbed watershed.

Large Woody Debris

LWD density is Poor for every reach in the East Fork of Issaquah Creek. The instream survey identified only three pieces of key LWD. Non-key pieces of LWD were more common than key pieces; however, overall LWD habitat was still Poor for every reach. MWD (i.e., wood not meeting requirements for LWD key pieces but still having a significant hydrologic or geomorphologic impact on the stream) were also more prevalent than key pieces.

Bank Condition

Bank condition is assessed in terms of bank stability and bank modification. Bank stability is rated Good for every reach. Reaches X and Y received Fair ratings for bank modifications (46 and 42 percent modified respectively), while Reach Z has a Good rating with only 13 percent of the banks being modified.

Benthic Index of Biotic Integrity

The City of Issaquah maintains B-IBI monitoring at one station on the East Fork of Issaquah Creek. King County no longer monitors B-IBI on the East Fork, but does have recent data obtained upstream of the Issaquah station. This station received a score of 22 in 1999 and 28 in 2000, rating Poor and Fair respectively. Although not enough data are available to make reliable judgments regarding chronological trends, conditions appear to be worsening over time. According to the 2007 State of Our Waters Report (City of Issaquah), the latest B-IBI scores (2006) for the East Fork Issaquah Creek were considered ‘Fair’. In 2005 the B-IBI scores for the East Fork were considered ‘Good’.

Properly Functioning Conditions (NMFS Pathways And Indicators)

Parametrix (2003) evaluated existing conditions in the East Fork Issaquah Creek in terms of the pathways and indicators criteria defined by NMFS (1996). Table 4-8 summarizes the results for each stream reach in terms of Properly Functioning, At Risk and Not Properly Functioning. This section also provides brief descriptions of the indicators associated with the major pathways and provide a summary for each reach.

Table 4-8 East Fork Issaquah Creek Habitat Conditions Summary by Reach (Data are from Parametrix, 2003)

Pathway	Indicator	Reach			
		X	Y	Z	ZZ*
Water Quality	Temperature	○	○	○	○
	Sediment/TSS	○	○	○	○
	Chemicals	○	○	○	○
Habitat Access	Physical Barriers	○.	○	○	○
Habitat Elements	Substrate	⊙	⊙	●	●
	Large Woody Debris	●	●	●	●
	Pool Frequency	●	●	●	●
	Pool Quality	●	⊙	●	●
	Off-channel Habitat	●	●	⊙	⊙
Channel Condition and Dynamics	Bank Condition	⊙	⊙	○	○
	Floodplain Connectivity	●	●	⊙	⊙
Flow/Hydrology	Change in Peak flows	●	●	●	●
Watershed Condition	Road Density	⊙	⊙	⊙	⊙
	Riparian Reserves	●	●	●	●

○ Properly Functioning
⊙ At Risk
● Not Properly Functioning

* Evaluation of Reach ZZ was not included in the 2003 Stream Inventory. Based on review of aerial photography and PHS data, it appears that conditions in Reach ZZ are similar to those described for Reach Z.

4.2.3.3 Summary of Habitat Conditions by Reach

Reach X

Reach X of the East Fork of Issaquah Creek extends from its confluence with Mainstem Issaquah Creek to Front Street, a distance of about 1,100 feet. Principal issues in this reach include a lack of large wood, deeper pools, and off-channel habitat. The stream is confined, incised, and lacks floodplain connectivity through this area. Both banks are cloaked in Himalayan blackberry, and there is a general lack of riparian overstory. Problems chronic to the Mainstem of Issaquah Creek, but which are believed to be less severe or limiting in the East Fork, include degraded or non-functional riparian refugia for juvenile salmonids, and suspended sediment.

Reach Y

Reach Y of the East Fork of Issaquah Creek extends from Front Street to the lower I-90 crossing, a distance of about 4,900 feet. The predominant land use between Front Street and I-90 is low-density residential use on either side of the creek. Riparian buffer is essentially non-existent, with residential landscaping often coming to the creek's edge. At the time of the 2003 Stream Inventory, construction of the Sunset Way interchange was well underway, converting some open space to freeway ramps and landscaped slopes.

Limitations in Reach Y are the same as those in Reach X, except Pool Quality was upgraded from Not Properly Functioning to At Risk. While no pools 3 feet deep were seen in Reach X, one roughly 2 feet deep was seen in this reach. The Properly Functioning condition of 3 feet for quality pools (NMFS 1996) may not be realistic for a stream as small as the East Fork (the USBEM criteria is usually 0.8 ft); however, historic levels of large wood may have created pools of this size. Current construction of the Sunset Way interchange has eliminated riparian vegetation and trees over portions of both banks, and exposed more of the creek to insolation (solar radiation) and erosion of sediment.

Reach Z

Reach Z of the East Fork of Issaquah Creek extends from the lower I-90 crossing to the third I-90 crossing, a distance of about 2,000 feet. A major feature of the East Fork above RM 0.9 is I-90, which crosses and re-crosses the creek. Land use further from the highway is open space or undeveloped forested slopes. Habitat improves appreciably as one moves up the East Fork out of the residential and interchange construction areas. However, the chronic habitat limitations of lack of LWD and associated pools continue. Plunge pools below some of the weirs provide some substitute, but are not the quiet water preferred by newly emerged fry. A high percentage of streambed riffles had excessive embeddedness.

Reach ZZ

Reach ZZ of the East Fork Issaquah Creek extends from the fourth I-90 crossing to the fifth I-5 crossing, a distance of approximately 1,250 feet. Conditions in Reach ZZ were not characterized in the 2003 Stream Inventory. Based on information available, it is likely that many of the conditions in Reach ZZ are similar to those in Reach Z. I-90 and the West Tradition Plateau/West Tiger Mountain Natural Resources Conservation Area are the major land use features within this reach. The majority of the open channel portions of Reach ZZ (left bank) is undeveloped and forested, while a large portion of this reach is culverted beneath the I-90 corridor. Although habitat conditions improve outside of residential areas, this reach is similar to Reach Z in that habitat forming processes including those associated with LWD are limiting.

4.2.4 Built Environment

4.2.4.1 Existing Land Use, Comprehensive Plan Land Use, and Zoning

Land use patterns along the shoreline of the East Fork are a mix of commercial, residential and conservancy. This land use pattern has not dramatically changed since publication of the Stream Inventory. The East Fork Issaquah Creek shoreline planning area has experienced a great deal of alteration associated with urban development. Road projects including the construction of I-90 and the recent Sunset Interchange project represent a particularly significant source of alteration to the East Fork within the City's jurisdiction. Map 22 (Appendix A) shows zoning along the East Fork reaches. The City's Comprehensive Plan land use designations are shown in Map 17 (Appendix A).

Existing land use within the East Fork shoreline planning area was assessed using 2007 King County assessors parcel data. In general, the City's East Fork shorelands are dominated by I-90. In combination with other street rights-of-way, approximately 59 percent of the total East Fork shoreline planning area is classified as transportation. Transportation makes up an increasingly large proportion of the shoreline as one moves up the creek. Transportation makes up 25, 56, 64, and 99 percent of the City's shoreline jurisdiction in Reaches X, Y, Z, and ZZ respectively.

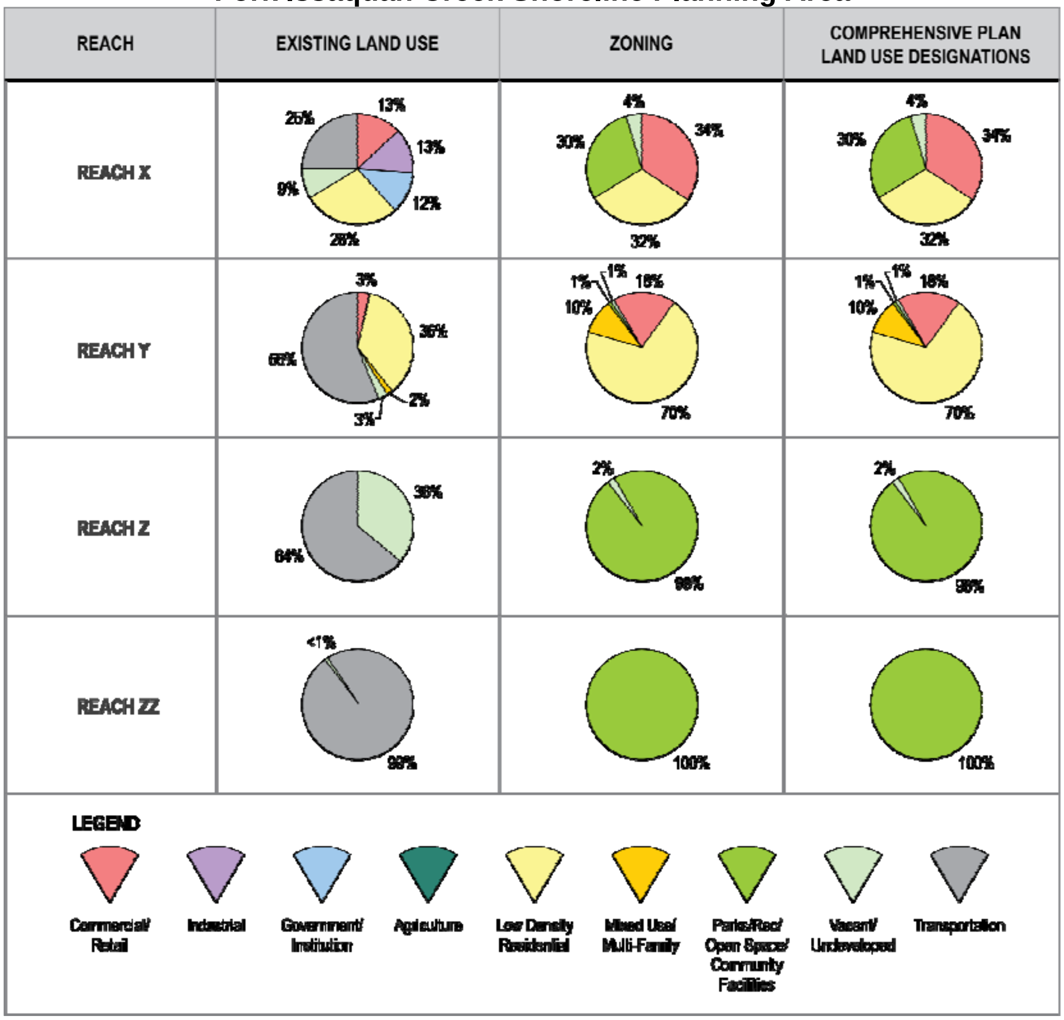
The land use pattern along the East Fork is more diverse in the lower reaches. Reach X, of which the City's CBD makes up a majority, includes areas classified as office/retail (13 percent), industrial (13 percent), government/institutional (12 percent), and low-density residential (28 percent). Reach Y is dominated by low-density residential development (36 percent).

As described for the Mainstem Issaquah Creek, the City's zoning and Comprehensive Plan land use designations are essentially the same within the East Fork shoreline planning area. Excluding transportation, approximately half of the planning area along the East Fork is zoned for low-density residential development (47 percent). Zoning for parks, recreation, and open space (26 percent) and office/retail (18 percent) are the other significant allowed and planned uses. All of the residential and commercial/retail zoning is located in the lower reaches, X and Y. The upper reaches, Z and ZZ, are zoned and planned exclusively for park or conservancy uses.

Figure 4-6 shows the proportions of current land use and zoning (comprehensive plan land use designations are consistent with zoning) for each East Fork shoreline reach. The data for city zoning exclude roadways. Roads are included in the existing land use data.

According to the Ecology statewide GIS database of facilities with suspected or confirmed contaminated sites, and facilities with the potential to introduce contamination into the environment, there two sites listed (both is Reach X). The first is the City's building facilities and Parks Maintenance Shop. It is listed as hazardous waste generator. The second is the Darigold facility, which is listed as having an underground storage tank (UST). No other toxic or hazardous waste sites were identified in the East Fork Issaquah Creek shoreline.

Figure 4-6 Percentages of Existing, Allowed and Planned Land Use by Reach in the East Fork Issaquah Creek Shoreline Planning Area



4.2.4.2 Water-oriented Uses

The East Fork shoreline does not currently have any water-dependent or water-related uses as described in Table 4-4. A review of King County assessors data revealed that there is only one property classified as industrial and approximately 12 properties classified as commercial or retail within or partially within the East Fork shoreline. The industrial property is the Darigold creamery, which would not be considered a water-dependent or related use. None of the commercial/retail uses would be considered water-dependant or –related uses. As with the Mainstem there are limited opportunities for water-dependent or –related uses in the East Fork shoreline because of the creek's physical characteristics and the existing land use pattern. Future demand for such uses is expected to be low.

Water-enjoyment uses in the shoreline include the public parks and open spaces described in section 4.2.4.4 and could include restaurants or other publicly accessible businesses that offer visual or physical access to the creek.

4.2.4.3 Impervious Areas

As described for the Mainstem, impervious areas were also analyzed for the East Fork Issaquah Creek shoreline planning area based on the City's impervious areas GIS data (See Map 28 in Appendix A). Table 4-9 shows the total impervious area and percent of impervious area for the lower reaches of the East Fork. The table also shows the proportions of roads and buildings in the total impervious area. The percentages of impervious area are reflective of the highly developed nature of Reaches X and Y.

The City's impervious data do not cover the upper reaches (Z and ZZ) of East Fork Issaquah Creek. A qualitative measure of impervious surface in those reaches can be intuited by looking at the land use pattern within the shoreline planning area of Reaches Z and ZZ. Both reaches are characterized by undeveloped open space interspersed with I-90. The presence of I-90 in both reaches creates a substantial amount of impervious surface in both.

Table 4-9 Impervious Surface in the East Fork Issaquah Creek Shoreline Planning Area

Reach	Total Acres	Impervious Area (Acres)	Percent Impervious	Roadway % of Total Impervious areas	Building % of Total Impervious areas
X	10	4	39	32	48
Y	45	12	27	31	37
Z	No data				
ZZ	No data				

Source: City of Issaquah GIS data (2006)

4.2.4.4 Parks, Open Space, and Public Access

Public access to the East Fork is relatively limited compared to the Mainstem. Park properties or public access along the creek in the lower reaches (X and Y) is provided by a limited number of parks and open spaces. As discussed for the Mainstem, the property at the southeast corner of the confluence of the East Fork and Mainstem is currently used as a parks/facilities shop. It is programmed to be part of the Issaquah Creek and Cybil Madeline park site in the future. The Rainier multiple use trail, which is located along Rainier Boulevard, also crosses the East Fork.

Access to the shorelines in the upper reaches (Z and ZZ) is limited by the presence of I-90. Public access is available where the creek flows through the West Tradition Plateau/West Tiger Mountain Natural Resources Conservation Area (NRCA).

4.2.4.5 Transportation and Utilities

The 2003 Stream Inventory catalogued stormwater outfalls and culverts in the East Fork shoreline. The inventory noted two culverts at the mouth of tributaries just downstream of the creek's first I-90 crossing. The Stream Inventory only reported the presence of one outfall, located at Front Street (Figure 4-3).

I-90 crisscrosses the East Fork three times within the City limits, and the East Fork passes under seven more bridges. In the lower reaches, 13 bridges cross the East Fork, including three bridges within 100 yards of Rainer Boulevard to Front Street. Further upstream, a foot bridge crosses just below the Dogwood Street Bridge, followed by another footbridge at 3rd Avenue.

4.2.4.6 Historic and Cultural Resources

Native American and Euroamerican historic use of the Issaquah area is detailed in Section 4.1.4.5 (Historic and Cultural Resources – Main Stem Issaquah Creek). A search of the DAHP database indicated that there are no state or federally registered sites within the East Fork shoreline planning area, but there are several inventoried sites. These include:

- The Gilman Water Company / Old Issaquah Water Works (KI-452): two adjoining concrete structures and an intake structure that remain from a water works / reservoir facility first constructed in 1893. The facility, modified over the years, diverted water from a tributary stream to East Fork Issaquah Creek. The facility, which is no longer used and is now surrounded by forested areas, is located to the east of East Fork Issaquah Creek at the Interstate 90 crossing, near E Sunset Way.

- Historic Railway Grade of the Seattle, Lake Shore & Eastern Railroad (KI-451): The railroad grade extends to the north and south of East Fork Issaquah Creek near the Interstate 90 and E Sunset Way interchange. The area of the railroad crossing the stream was supported by a trestle, which no longer exists.

- Poured Concrete and Block Foundation (KI-453): This structure is located along the right (north) bank of East Fork Issaquah Creek. Constructed between 1955 and 1968.

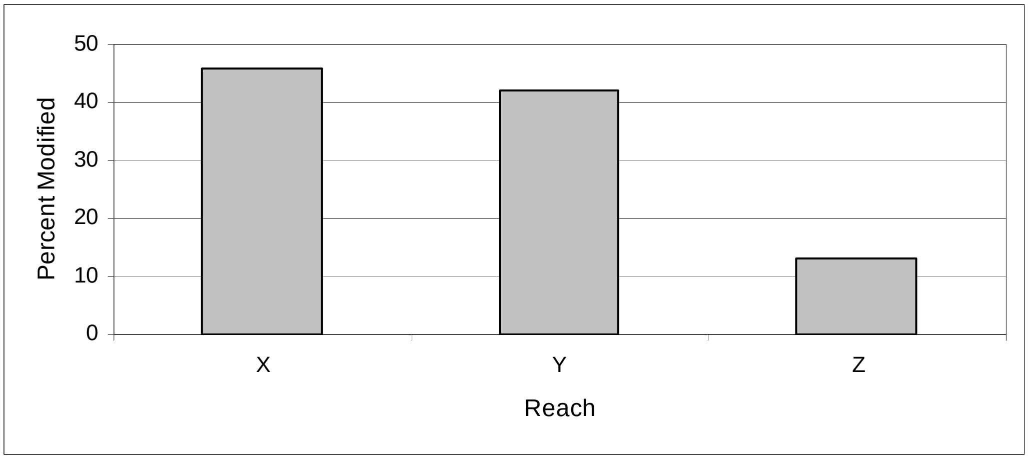
Cultural resources assessments have been prepared for projects within the East Fork Issaquah Creek shoreline planning area. These reports identified several structures that meet minimal historic criteria per the WHR and the NRHP. The White Swan Inn, a wood framed structure built in 1916, was documented as being eligible for listing. All other documented structures were determined to be of minimal historic significance, and as such were not recommended for designation as historically significant or other protection.

Review of cultural resources reports indicates that areas along the East Fork shoreline are noted for having a moderate degree of potential due to ethnographic use by the Sammamish and other area tribes (Archeological Investigations Northwest, Inc., 1999; Jones and Stokes, 2005).

4.2.4.7 Shoreline Modifications

The 2003 Stream Inventory indicated that large areas of the East Fork Issaquah Creek shoreline have been modified in the lower Reaches, X and Y. Far less shoreline was reported as modified in Reach Z. Reach ZZ was not surveyed as part of the 2003 Stream Inventory. However, because conditions in that reach are similar to conditions in Reach Z, the extent of shoreline armoring is likely similar. Figure 4-7 shows the percentages of shoreline modification for each reach along the East Fork within the City limits. Maps 12 through 16 (Appendix A) show the shoreline riparian conditions catalogued in the Stream Inventory.

Figure 4-7 East Fork Issaquah Creek Percent Bank Modification by Reach



Source: Parametrix, 2003

4.3 Lake Sammamish

Lake Sammamish is the sixth largest lake in the state of Washington and the second largest lake in King County (after Lake Washington). The lake drains approximately 63,000 acres of land and has a mean depth of about 58 feet and a maximum depth of 105 feet (King County, 1994). Issaquah Creek contributes approximately 70 percent of the surface flow to Lake Sammamish (Entranco et al., 1996). Tibbetts Creek, which enters the lake west of the Issaquah Creek mouth, is the second largest tributary, contributing approximately 6 percent of surface flow. The third major tributary is Pine Lake Creek, which is located within the City of Sammamish and contributes about 3 percent flow (Entranco et al., 1996). The lake discharges via the Sammamish River at the north end of the lake, where a flow control weir at Marymoor Park controls the discharge volume and rate.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map, the Lake Sammamish flood level is 33 feet above sea level (National Geodetic Vertical Datum [NGVD] 1929)[30]. Table 4-10 shows some of the properties of Lake Sammamish.

Table 4-10 Physical Attributes of Lake Sammamish

Attribute	Lake Sammamish
Surface Area	4,897 acres
Lake Volume	283,860 acre-ft
Maximum Depth	105 ft
Average Depth	58 ft

Source: http://dnr.metrokc.gov/wlr/waterres/lakes/LakeSammamish.htm

[30] Lake elevations are generally given in one of two datum: NAVD 88 or NGVD 29. The difference between the NGVD 29 and NAVD 88 datum in the vicinity of Bellevue is +3.585 feet (Watershed Company, 2004) .

Lake Sammamish has a turnover or flushing rate of about 56 percent per year and the volume of water in the lake is completely replaced approximately every 1.8 years. This relatively long hydraulic residence time (Lake Washington, which is twice as large and twice as deep, flushes at about the same rate as Lake Sammamish) means that nutrients and other pollutants can build up in the lake, which creates challenges for maintaining good water quality.

4.3.1 Critical Areas

Critical area regulations and protections referenced in Section 4.1.1 for the Mainstem Issaquah Creek also apply to the critical areas in the Lake Sammamish shoreline planning area.

4.3.1.1 Geologically Hazardous Areas

Seismic hazard areas, as mapped by the City of Issaquah (Map 6), extend across the majority of the City's Lake Sammamish shoreline planning area. Only the areas surrounding the mouths of Tibbetts and Schneider Creeks are outside of the mapped seismic hazard areas.

Erosion hazard areas and landslide hazard areas are also mapped along the City's Lake Sammamish shoreline, but are limited to the northwestern and northeastern reaches (Lk_Sam01 and Lk_Sam03) (Map 6). Within Reach Lk_Sam01, landslide hazard areas are mapped within and surrounding Timberlake Park. Within Reach Lk_Sam03, erosion hazard areas are mapped in the area surrounding the mouths of Many Springs and Laughing Jacobs Creeks.

4.3.1.2 Aquifer Recharge Areas

According to the City's CARA mapping, there are no designated CARAs within the Lake Sammamish shoreline planning area. According to King County (2005a), the majority of the lake's shoreline planning area has low susceptibility to groundwater contamination.

4.3.1.3 Flood Hazard Areas

FEMA has identified the 100-year floodplain along Lake Sammamish to include the shoreline areas up to elevation 33 feet (NGVD 1929). The floodplain elevation near the mouth of the Mainstem Issaquah Creek is about 1 foot higher (34 feet) due to influences from the creek. The lake level is controlled to allow only 3 feet of fluctuation, so seasonal changes in the lake surface water elevation are the opposite of what might be expected in a natural system. Average lake levels are highest in May and June, and lowest in December and January, whereas under natural conditions lake levels would be highest in the winter and lowest in the summer (USCOE, 2004c).

4.3.1.4 Wetlands

The primary potential wetland areas associated with Lake Sammamish are within Lake Sammamish State Park, a PAA of the City (Reach Lk_Sam02) (Map 3)[31]. Within the City's

[31] Wetlands described in this report have not been field-verified. Therefore, this report should not be construed as providing a comprehensive inventory of all wetlands in shoreline jurisdiction, as additional wetlands may be present and some areas mapped as wetland may not meet the wetland criteria.

shoreline planning area, wetlands are located along the margins of Lake Sammamish and near the mouth of Tibbetts Creek and Issaquah Creek. The wetland complex associated with Tibbetts Creek (referred to as Wetland LS1 in the Stream Inventory) extends along the creek and into the broad low-lying area between Lake Sammamish and I-90. Developed areas of the State Park bound the eastern edge of this wetland complex. The western edge of the complex abuts residential development along the lakeshore.

The forested, scrub/shrub, and emergent portions of the Tibbetts Creek wetland complex are estimated at approximately 27.2 acres. Much of the peninsula surrounding the creek mouth is forested wetland. The tree canopy is composed of Pacific willow (*Salix lasiandra var. lucida)* and black cottonwood. Red alder and an individual specimen of Pacific madrone (*Arbutus menziesii*) are present in the area as well. Live and dead willows extend down to and beyond the waterline, extending some 10 to 20 feet over the water (Parametrix, 2003)

Along the lake shoreline, there is abundant woody debris primarily consisting of willow and cottonwood. The vegetation in the understory is dominated by Himalayan blackberry, though hardhack, red-osier dogwood, red elderberry, and salmonberry are also present (King County 1990). The emergent vegetation is dominated by reed canarygrass, with lady fern and morning-glory present in smaller amounts. Some small patches of cattail and smartweed also occur along portions of the peninsula. The rooted aquatic vegetation consists largely of yellow pond-lily.

West of the mouth of Tibbetts Creek, the canopy is dominated by the same species as to the east, but is more open. The emergent layer has greater percentages of reed canarygrass, and yellowflag iris is present in fairly large patches. Five standing dead trees were noted in the immediate area.

The large wetland complex associated with the lower portion of Issaquah Creek and the Lake Sammamish shoreline (Issaquah Creek wetland complex) shows many of the same vegetation characteristics as the Tibbetts Creek wetland, however portions of this wetland complex may have higher levels of dominance by invasive species (primarily Himalayan and evergreen blackberry and reed canarygrass) (Watershed, 2005). In addition, the emergent and scrub/shrub habitat components make up a far more significant component of the Issaquah Creek wetland complex than the Tibbetts Creek wetland. The Lake Sammamish State Park Wetland, Stream and Lakeshore Restoration Plan details conditions within this wetland complex, and throughout the State Park, and provides a sequenced restoration frame work for improving the wetland's functions (Watershed Company, 2005). This wetland complex makes up much of Lake Sammamish State Park (the majority of areas that are undeveloped with recreational facilities) and extends to the south out of the park. Southern portions of the Issaquah Creek complex, however, are associated with the creek and are described in Section 4.1.1.4 (Mainstem Issaquah Creek Wetlands).

The Tibbetts Creek and Issaquah Creek wetland complexes are considered lake fringe wetlands. Within both wetlands, the water source is primarily precipitation, but the creeks provide lateral surface water transportation, especially during storm events. Hydrodynamic properties would be classified as largely vertical fluctuation, but the creeks provide a unidirectional flow to parts of the wetland areas, especially during high-flow events.

The wetland complexes have limited potential to remove sediments and toxicants from waters flowing into the lake because of their location within the lower watershed. Woody vegetation along the lake shoreline stabilizes banks and controls shoreline erosion in these areas.

4.3.2 Water Quality

Lake Sammamish is considered to have a mesotrophic (as opposed to eutrophic) state, meaning it has moderate levels of biological activity, moderate water clarity, moderate algal growth, and moderate phosphorus concentrations. The tropic status is very important because it can affect ecological health and habitat quality (e.g. dissolved oxygen levels), aesthetics (algal blooms), and recreational use. If the tropic status were to change from mesotrophic to eutrophic, a number of adverse effects could occur including:

- Noxious algae;
- Loss of open water due to excessive macrophyte growth;
- Loss of clarity;
- Loss of habitat for fish and fish food (low dissolved oxygen);
- Smothering eggs and invertebrates (excessive organic matter production); and
- Odors due to 'toxic' gases (ammonia, hydrogen sulfide) in bottom water.

Between 1994 and 2004, the trophic state index (TSI) for Lake Sammamish as measured by King County averaged between 35 and 42 on a scale of 1 to 100[32], suggesting that conditions hover on the edge between mesotrophic (an intermediate level of productivity; TSI between 40-50) and oligotrophic (low level of productivity; TSI below 40) (King County, 2005b).

There are seasonal variations in transparency or water clarity within Lake Sammamish. Transparency is typically lowest during the winter months when chlorophyll levels are low and streams deliver increased quantities of fine sediment, which creates turbid conditions. Summer transparency levels are higher as stream inputs become less important and primary productivity increases in response to higher temperature and increased daylight.

The lake also experiences seasonal changes caused by thermal stratification. Between mid-May and mid-November, there are distinct density and temperature differences between different layers of the water column (cold, dense water on the bottom, warmer less dense water near the surface). Algae take up nutrients, which are then transported to the bottom when the algae die. Dissolved oxygen becomes more limiting at depth, thereby reducing food availability and habitat for species such as Chinook salmon that require access to cooler water. In the spring and fall, the thermal stratification breaks down, the water column becomes more mixed, and nutrients that have accumulated at the bottom of the lake are redistributed throughout the water column. Dissolved oxygen levels at all depths are higher than during the stratified period (summer).

The state has established specific goals for water transparency, chlorophyll, and total phosphorus in Lake Sammamish as follows:

[32] Each major division correlated to a doubling of the algal biomass related to water clarity and nutrient levels.

- Transparency = June to September mean water transparency of 4 meters or more.
- Chlorophyll *a* = June to September mean below 2.8 µg/liter.
- Total Phosphorus = annual volume weighted concentration equal to or less than 22 µg/liter.

Total phosphorus levels in Lake Sammamish have tended to range from about 13 to 22 µg/L mean annual volume weighted total phosphorus per calendar year, which meets the target threshold. This is based on sampling conducted between 1997 and 2005 at two stations located at the north and south ends of the lake[33]. Transparency and total phosphorus levels generally met the established targets, but chlorophyll *a* levels exceeded the target threshold in most years between 1997 and 2005[34].

Although Lake Sammamish meets water quality standards for phosphorus, the lake is at risk for several other water quality parameters. Currently, Lake Sammamish is on Ecology's 303(d) list, as a Category 5 waterbody for ammonia N, dissolved oxygen, and fecal coliform[35].

4.3.3 Biological Resources

4.3.3.1 Fish and Wildlife Presence

Lake Sammamish provides significant habitat to native fish species including Chinook, coho and sockeye/kokanee salmon, as well as steelhead/rainbow trout and coastal cutthroat trout. Resident and anadromous species use Lake Sammamish primarily for rearing and as a migratory route. Sockeye and kokanee salmon also use portions of the lakeshore for spawning, although lake spawning data are limited[36].Other native fish species in the watershed are western brook lamprey, river lamprey, peamouth chub, largescale sucker, mountain whitefish, and one or more species of sculpin.

Invasive warmwater species of fish in Lake Sammamish include both large and smallmouth bass, yellow perch, black crappie, pumpkinseed sunfish, and brown bullhead. These non-native species, particularly adult perch and bass, are known to be predators of juvenile salmon and their young will also compete with salmon for food in shallow water habitats (King County, 2005c). Smallmouth bass tend to be found along the lake's western and eastern shores, rather than at the

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[33] King County data available at http://dnr.metrokc.gov/wlr/waterres/lakes/LakeSammamish.ht

[34] King County data available at http://dnr.metrokc.gov/wlr/waterres/lakes/LakeSammamish.ht

[35] Category 5 refers to polluted waters that require a TMDL. (Ecology 303(d) water quality data are available at http://www.ecy.wa.gov/programs/wq/303d/index.html).

[36] The East Lake Sammamish Basin Plan (King County, 1994) includes a map of known sockeye spawning areas along the east Lake Sammamish shoreline. The King County Department of Natural Resources and Parks, Water and Land Resources Division conducted spawning surveys in many tributaries as part of their study entitled the *Current Status of Kokanee in the Greater Lake Washington Watershed* (Berge and Higgins, 2003).

shallow southern and northern ends (Pflug 1981, Pfeifer and Weinheimer 1992; Fresh et al. 2001; Tabor and Piaskowski 2001).

The WRIA 8 Technical Committee designated the Lake Sammamish shoreline as a "Tier 1" evaluation area for migrating and rearing Chinook salmon populations (King County et al., 2005). Also, in 2007, the City of Issaquah, along with King County, People for Puget Sound, Save Lake Sammamish, The Wild Fish Conservancy, Trout Unlimited and the Snoqualmie Indian Tribe petitioned the US Fish and Wildlife Service to define and list all wild, indigenous, naturally-spawned, kokanee in Lake Sammamish as a threatened or endangered species under the Endangered Species Act (ESA) (City of Issaquah et al., 2007). Historically, kokanee were distributed throughout the Lake Sammamish and Lake Washington basins (Berge and Higgins, 2003). Currently, native kokanee are limited to a few southern creeks (late run) and are completely gone from the largest tributaries and subbasins in the Lake Sammamish basin (City of Issaquah et al., 2007). This represents a significant contraction of the spatial distribution of the population. In addition, the spawning habitat is very contracted. Currently because of fish passage barriers, the longest accessible spawning stream is only 0.75 miles and the total spawning area of all streams is less than one mile. Lewis Creek is one of the most productive of the remaining late-run kokanee streams. Ebright Creek and Laughing Jabobs Creek in Sammamish also help sustain the late-run kokanee population, although escapement numbers remain critically low (City of Issaquah et al., 2007). Federal action on the listing petition is pending. The US Fish and Wildlife Service will make one of three possible determinations: 1) ESA protection is not warranted, in which case no further action will be taken; 2) Protection as threatened or endangered is warranted, or 3) ESA protection is warranted but precluded by other, higher priority activities.

The Lake Sammamish shoreline provides quality habitat for numerous species of terrestrial wildlife. Significant areas within the Reach Lk_Sam02 shoreline area are largely undeveloped and provide high value habitat to avian species. Bald eagles are known to forage along the lake and perch in large cottonwoods on the shoreline (Parametrix, 2000). Great blue herons breed in rookeries at Lake Sammamish State Park (Reach Lk_Sam_02), and some of these birds use the nearshore areas for foraging and rearing. Avian predators, such as osprey and red-tailed hawks, are frequently observed near the lakeshore. Mergansers, cormorants, mallards, grebes, American coots, Canada geese, gulls, swifts, green herons, and other waterfowl occupy open water areas. The State Park is a designated waterfowl concentration area.

4.3.3.2 Shoreline and Riparian Habitat Conditions

The majority of the Lake Sammamish shoreline is vegetated with grasses. A large percentage of this vegetation is in the form of landscaped yards (mowed lawn). However extensive areas of reed canarygrass occur within Reach Lk_Sam02. Landscaped yards also include ornamental shrubs and trees.

Dense stands of medium-size deciduous trees cover significant areas of the undeveloped shoreline. These areas are primarily within the State Park (Lk_Sam02); however they occur in small portions of Reaches Lk_Sam01and Lk_Sam03 as well. Within Reach Lk_Sam02, there are dense stands of deciduous trees associated with the Tibbetts and Issaquah Creek wetland complexes. The lack of coniferous forest on the lake shoreline is due to development for residential uses and because large areas of the State Park are devoted to more open types of land cover.

Overhanging vegetation and natural woody debris in the water provide cover for juvenile salmon emigrating from spawning and early rearing areas in Issaquah and Tibbetts Creeks. Juvenile Chinook fry and pre-smolts use woody debris in the nearshore for cover particularly during the day. Overhanging vegetation also provides food for Chinook and other fish species in the form of terrestrial insect fallout (Koehler et al. 2000; Koehler 2002). Depending on stem and branch density and substrate composition, woody debris extending into the water may also provide habitat for non-native predators such as bass (Aggus and Elliott 1975). The silty, muddy shorelines of the small bay on the southwest corner of the Tibbetts Creek peninsula would tend to favor largemouth bass; sandy or gravelly areas would tend to favor smallmouth bass (Pflug 1981). The relatively loose, open character of the wood in the water at this peninsula provides structure that is used by bass for ambush habitat, thus potentially offsetting the cover and rearing habitat benefits otherwise available to salmon fry.

The more developed reaches of City shoreline (Lk_Sam01 and 03) are substantially degraded from the natural condition, with almost no vegetation overhanging the water, and virtually all native vegetation removed. Private docks and piers are known to provide structure that attracts non-native predators, particularly smallmouth bass (Pflug 1981; Fresh et al. 2001). Where sand or small gravel on moderate slopes exists, juvenile Chinook and coho would be expected to forage for invertebrates (Koehler 2002; Tabor and Piaskowski 2001). These conditions, which favor migrating and feeding Chinook, exist along portions of the developed reaches, but the habitat has not been evaluated in detail.

4.3.4 Built Environment

4.3.4.1 Existing Land Use, Comprehensive Plan Land Use, and Zoning

Most of the jurisdictional shorelands of Lake Sammamish are within Lake Sammamish State Park (Reach Lk_Sam02), which is a Potential Annexation Area of the City. The updated SMP will include polices and regulations for the PAA, but they will only apply once an annexation occurs. Because of this, City zoning and Comprehensive Plan land use designations are not applied to the State Park. Therefore the descriptions of existing shoreline land uses include the State Park, but the percentages of zoning do not.

In general, existing land use within the Lake Sammamish shoreline planning area is a mix of low-density residential (10.3 percent), parks and open space (59 percent), and undeveloped lands (22 percent). The percentages are highly influenced by the presence of the State Park, which comprises a predominant percentage of the Lake Sammamish shoreline planning area (78 percent). The shoreline planning area within the current city boundaries (excluding the State Park) is predominantly low-density residential (45 percent) and commercial/retail (24 percent) with the remainder in parks and open space (9 percent) and transportation (12 percent).

At the reach scale, the three Lake Sammamish shoreline reaches represent three distinct land use patterns. The most western shoreline reach (Lk_Sam-01) includes the shoreline of the Greenwood Point neighborhood. Existing land use in this shoreline reach is predominantly low-density residential (79 percent). The balance of shoreline land uses are roadways (11 percent) and undeveloped lands (10 percent). The eastern most shoreline reach (Lk_Sam_03) is relatively small, consisting of approximately 5 acres. Of that area, approximately half (52 percent) is multi-family residential, with another 20 percent low-density residential, and 24 percent classified as vacant/undeveloped.

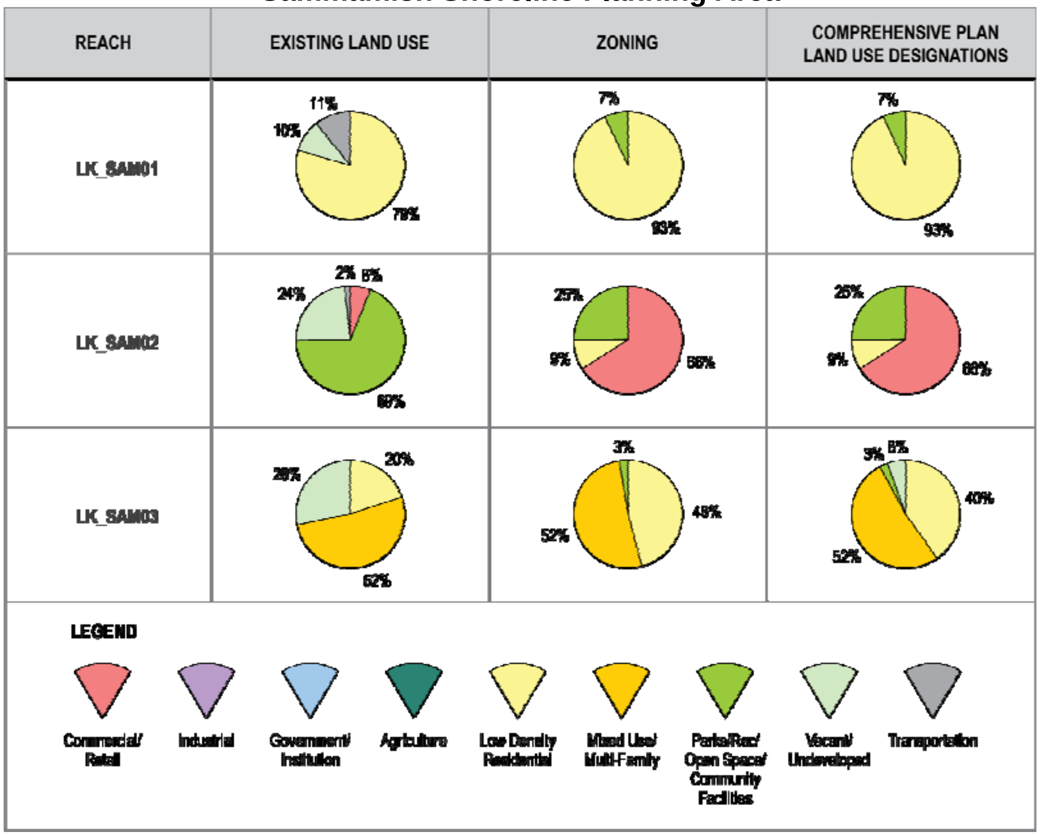
As noted above, the majority of jurisdictional shorelands in Reach Lk_Sam02 are located in Lake Sammamish State Park, which is in King County jurisdiction. Of a total of 306 acres, 278 acres (91 percent) are within the State Park. Current county zoning in the State Park is R-4 (Residential, 4 dwelling units per acre). The areas of this reach within the City's current shoreline planning area include the commercial area (approximately 19 acres) immediately west of the East Lake Sammamish Parkway and a portion of the East Lake Sammamish trail.

The City's Zoning and Comprehensive Plan land use designations in the Lake Sammamish shoreline planning area are consistent. Nearly all of the shoreline planning area in the western most reach (Reach Lk_Sam01) is zoned and planned for low-density residential development (93 percent). Most of the remainder is within Sammamish Cove Park. Of those shorelands within City jurisdiction, the majority are zoned and planned for commercial/retail uses (66 percent). Zoning and planned land uses in the eastern Lake Sammamish shoreline reach (Lk_Sam03) allow primarily multi-family (52 percent) and low-density residential (46 percent) uses. Map 18 (Appendix A) shows zoning in the Lake Sammamish shoreline. The City's Comprehensive Plan land use designations are shown in Map 17 (Appendix A).

Figure 4-8 shows the percentage of existing land use and zoning (comprehensive plan land use designations are consistent with zoning) for each of the Lake Sammamish shoreline reaches. Data for city zoning exclude roadways. Roads are included in the existing land use data.

According to the Ecology statewide GIS database of facilities with suspected or confirmed contaminated sites, and facilities with the potential to introduce contamination into the environment, there are no sites listed in the Lake Sammamish Shoreline Planning Area.

Figure 4-8 Percentages of Existing, Allowed and Planned Land Use by Reach in the Lake Sammamish Shoreline Planning Area



Note: Existing land use data include the State Park; zoning data include the City only.

4.3.4.2 Water-oriented Uses

The only water-oriented use in the City's Lake Sammamish shoreline is the boat launch in Lake Sammamish State Park. The park itself is considered a water-enjoyment use because it offers public access to the shoreline. Opportunities for water-dependent and –related uses are limited because of the existing land use pattern (predominantly single family development and park). Single family residential use, while not water-dependent by definition, is a preferred use according to the SMA. Demand for future lakeshore use is expected to consist mainly of single family residential use.

The primary land use in the western reach (Lk_Sam01) and a component of the eastern reach (Lk_Sam03) is single family residential. Although not designated as a water-oriented use, single family residences are considered a preferred use in the shoreline. There are approximately 136 lakefront parcels within the City's Lake Sammamish shoreline planning area, nearly all of which are single family residences. Of those, approximately 65 (48 percent) have building setbacks of 50 feet or less.

4.3.4.3 Impervious Areas

The City's impervious surface GIS data layer does not cover most of Lake Sammamish State Park or the recently annexed Greenwood Point neighborhood (see Map 24 in Appendix A). Therefore, a slightly different type of impervious surface analysis was performed. Total impervious surface was estimated based on existing land use classifications from the King County assessor data. Percentages of impervious surface were applied to each land use according to broad generalizations and numbers tabulated in NRCS 210-VI-TR-55 (1986). Using these percentages, impervious areas were determined for each lake shoreline reach, as summarized in Table 4-11. These impervious areas percentages are a general estimate. While they do not reflect precise site conditions, they do offer a broad view of a key indicator.

Table 4-11 Estimated Impervious Surface in the Lake Sammamish Shoreline Planning Area

Land Use	Reach Area (Acres)	Estimated Area of Impervious Surface (Acres)	Percent Impervious Estimate	Total Percent Impervious
Lk_Sam_01				
Low Density Residential	36	14	38	
Vacant/Undeveloped	4	< 1	10	
Transportation	5	5	95	
Total	**45**	**19**		**42**
Lk_Sam_02[1]				
Commercial/Retail	19	18	95	
Parks, Rec and Open Space	210	21	10	
Vacant/Undeveloped	72	7	10	
Transportation	5	5	95	
Total	**306**	**51**		**1**
Lk_Sam_03				
Low Density Residential	1	< 1	38	
Multi-Family Residential	3	2	65	
Vacant/Undeveloped	1	< 1	10	
Transportation	< 1	<1	95	
Total	**5**	**2**		**44**

[1] The 19-acres of commercial/retail and a small portion of the transportation acreage are within the City's current boundaries; the rest of Lk_Sam02 is within the Lake Sammamish State Park (PAA) currently in King County jurisdiction.

As shown, the west (Lk_Sam01) and east (Lk_Sam03) reaches of the Lake Sammamish shoreline planning area have relatively high percentages of impervious areas. This is reflective of their developed nature. Reach Lk_Sam03, which includes the State Park, has a relatively low percentage of impervious surface. Impervious surface is most likely lower in this reach than is reflected in the analysis. Because this method considers whole parcels it includes areas of parcels that may not have built structures within the shoreline reach. A significant area in the southeast corner of Reach Lk_Sam02 is a commercial area. While the entire parcel is classified as commercial, most of the structures and pavement on the parcels are located outside the shoreline planning area.

4.3.4.4 Parks, Open Space, and Public Access

There are several opportunities for both visual and physical access to the Lake Sammamish shoreline. There are two parks in Reach Lk_Sam01. Timberlake Park is a 24-acre King County-owned park located on West Lake Sammamish Parkway SE, near the western boundary of the City. The park features both active and passive recreational facilities and beach access along its approximately 400 feet of Lake Sammamish shoreline. The second public park in Reach Lk_Sam01 is Sammamish Cove Park. Sammamish Cove Park is a meadow located immediately west of Lake Sammamish State Park, off West Lake Sammamish Parkway SE. The land was purchased for the preservation of open space/wildlife habitat and does not include any facilities. Tibbetts Creek traverses the northwest portion of the site (City of Issaquah, 2003).

Reach Lk_Sam02 is almost entirely comprised of Lake Sammamish State Park. Lake Sammamish is a 512-acre park located at the southern tip of Lake Sammamish and contains approximately 6,900 feet of publicly accessible shoreline. The park includes swimming beaches and the only motorized boat launch on the lake. The park also includes natural open spaces with trails, some of which are located on either side of Mainstem Issaquah Creek, which crosses the park.

There are no public parks located in Reach Lk_Sam03. A portion of King County's Eastlake Sammamish Trail traverses the shoreline jurisdiction in that reach. The trail offers visual access to the lake, but no physical access.

4.3.4.5 Transportation and Utilities

A limited number of surface streets are located in the Lake Sammamish shoreline planning area. The only major roadway passing through it is East Lake Sammamish Parkway, which is a four-lane principal arterial. There are no mapped outfalls or bridges within the Lake Sammamish shoreline planning area.

4.3.4.6 Historic and Cultural Resources

Native American and Euroamerican historic use of the Issaquah area is further detailed in Section 4.1.4.5 (Historic and Cultural Resources – Main Stem Issaquah Creek).

Lake Sammamish is part of the usual and accustomed fishing area of the Muckleshoot Indian Tribe and the Snoqualmie Indian Tribe per the Treaty of Point Elliot. The lake has served as a cultural resource for the Muckleshoot, Snoqualmie, and Sammamish and other tribes who have harvested fish, wildlife, and plant species in this area for generations. Currently, the Lake Sammamish shoreline plays an important role in the Snoqualmie Tribe's Canoe Family Journey.

A search of the DAHP database indicated that there are no state or federally registered sites within the Lake Sammamish shoreline planning area. While not state or federally registered, the historic railroad grade of the 'Seattle, Lake Shore, & Eastern Railroad' has been inventoried and is detailed in materials on file at the DAHP offices (site KI00451). The remnants of this railway include areas that were excavated into hill slopes and the corridor that once supported a trestle in the vicinity of the East Fork of Issaquah Creek.

Planning efforts for several projects in proximity to the Lake Sammamish shoreline have required completion of cultural resource assessments. Charles T. Lutterall (Eastern Washington University, Archeological and Historical Services) prepared a cultural resources investigation report for development projects within Lake Sammamish State Park (Luttrell, 2002). During site investigation, two likely prehistoric cultural resources were encountered, both documented as flakes. In addition, investigations encountered a number of historic objects believed to be artifacts of historic farming activity. All resources, however, were determined to be ineligible for listing on the NRHP.

Paragon Research Associates prepared a cultural resources investigation report for the East Lake Sammamish Interim Use Trail planning efforts (Paragon Research Associates, 2000). URS Corporation (2005) prepared a cultural resources investigation report for a drainage improvements project within Lake Sammamish State Park. These reports collectively identify several objects and/or structures that are prehistoric and historic. However, all documented objects and/or structures were determined to be of minimal historic significance, and as such were not recommended for designation as historically significant or other protection.

The cultural resources reports note that within Issaquah's shoreline areas, potential for encountering culturally significant artifacts is low to moderate, with limited areas noted as high. Areas along the Lake Sammamish shoreline, specifically, were noted for having a moderate degree of potential due to ethnographic use by the Sammamish and other area tribes.

4.3.4.7 Shoreline Modifications

Conditions and processes along southern Lake Sammamish and throughout the rest of the Lake Washington / Lake Sammamish system have been greatly modified over the last 100 years. Key modifications include:

- Construction of the Ship Canal in 1916 created a new connection between Lake Washington and Puget Sound, causing the lake water surface elevation to drop approximately 9 feet in Lake Washington and 6 feet in Lake Sammamish. This exposed approximately 2 square miles of previously inundated shallow water area, reduced the Lake Washington and Lake Sammamish shorelines, drained wetlands along the lake, and changed the mouths of tributary streams (King County et al., 2005).

- The U.S. Army Corps of Engineers maintains the water level in the Lake Washington Ship Canal within a 3-foot range between 20 and 23 feet. The minimum water elevation is maintained during winter, in reverse of a natural annual hydro-cycle, to allow for annual maintenance of docks and other structures, minimize damage during winter storms, and provide flood storage volume. The maintained water level carries through to Lake Sammamish, where a 3-foot range between 30 and 33 feet is maintained (USCOE, 2004c)

- As a result of reduction of the Sammamish River gradient and flow patterns, the Sammamish River now represents a substantial thermal migration-barrier to adult salmon returning to their spawning grounds (King County et al., 2005)
- Residential, recreational, and historic development has modified the lake shoreline with bulkheads, fill, and localized dredging.
- Residential docks, piers and other overwater structures have been constructed along significant portions of the lakeshore.
- Changes in land use have increased stormwater runoff and input of sediment and other pollutants to the lake.

Shoreline modifications associated with residential development are most prevalent in Reaches Lk_Sam01 and Lk_Sam03, which are characterized by high to moderate density residential development with associated bulkheads, riprap, and docks. In contrast, the lakeshore in Reach Lk_Sam02, which lies within Lake Sammamish State Park, contains shoreline areas that are undeveloped and maintain a less modified physical environment.

An assessment of Lake Sammamish shoreline modifications was conducted based on interpretation of 2002 and 2007 King County aerial photography and 2007 Ecology oblique photography (Maps 34 - 36)[37]. The assessment shows that the Lake Sammamish shoreline is moderately to highly altered in most of Reach Lk_Sam01 (Map 34, Table 4-12). Notable exceptions are the publicly owned park properties (Timberlake Park and Sammamish Cove Park) which are not altered and contain approximately 1,200 feet of lake shoreline. Concrete bulkheads are present along approximately 70 percent of the parcels. Only 4 percent of parcels have unmodified shorelines. There are docks associated with approximately 91 percent of the single family residential parcels in this reach; 5 percent of these appear to have joint use docks. Dock lengths vary from approximately 50 to 100 feet, with spacing between docks I typically 70 to 140 feet. Only seven privately owned residential parcels within this reach do not have associated docks.

Reach Lk_Sam02 contains both natural or minimally modified shorelines and stretches of shoreline that are highly modified with active recreation areas (Map 35). Within this reach the entire lake shoreline is within Lake Sammamish State Park. Modifications within the State Park include two large swimming beach areas, which are cleared of vegetation and have setback bulkheads, and a large boat ramp facility. The boat launch is at the northeastern extent of Lk_Sam02, and contains nine ramps and six associated docks.

Within Reach Lk_Sam03, five larger, privately owned parcels contain a moderate level of shoreline modification (Map 36, Table 4-12). Currently, there are four docks within this reach, with one 150-foot-long, multiple-slip dock associated with a large, multi-unit development. Shorelines in this reach do not have hard bulkheads and are at least partially vegetated.

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[37] Although the oblique photography is recent, this analysis may not contain all of the most recent dock or shoreline armoring developments.

Table 4-12 Summary of Lake Sammamish Shoreline Modifications

Category	Lk_Samm01		Lk_Samm02		Lk_Samm03	
	# of parcels	% of total	# of parcels	% of total	# of parcels	% of total
Total parcels	128	100	3	100	5	100
Parcels with private residential docks	110	86	Not applicable: Lk. Sammamish State Park contains a major public boat ramp facility and no other docks		3	60
Parcels with joint use residential docks	7	5			1	20
Parcels with hard shoreline armoring	88	69	0	0	1	20
Parcels with moderate shoreline armoring (no bulkhead, some vegetation and/or areas of natural vegetation)	35	27	2	66	3	60
Parcels with natural (unmodified) shorelines	5	4	1	33	1	20
Parcels with building setback of less than 50 feet	65	51	0	0	0	0

Sources: Orthophotography (King County, 2002 AND 2007) and oblique photography (Ecology, 2007)

Shoreline modifications are a significant concern along Lake Sammamish. Docks and piers create artificial shading that reduces the amount of light available to phytoplankton and aquatic macrophytes, which can decrease primary productivity and ultimately reduce fish and invertebrate diversity (Kahler, 2001). Bulkhead construction has also eliminated shoreline vegetation and displaced shallow-water refuge and foraging habitat for juvenile salmonids. Bulkheads can also change the slope, configuration, and/or substrate composition of the shoreline by cutting off upland sediment supply and increasing erosion on neighboring properties without bulkheads. In relatively low energy environments like Lake Sammamish, these effects tend to be localized, but they can still have adverse implications for aquatic habitat (Kahler, 2000).

Artificial shoreline structures alter natural predator-prey interactions and tend to create favorable conditions for predator fish species such as sculpin and smallmouth bass. Prey species require complex cover (such as brush piles, rootwads, and undercut banks) to avoid predators. In developed lakes, where natural cover has been replaced by artificial structures, prey species can become more vulnerable to ambush and other forms of predation. Some evidence suggests that predator species actually aggregate near piers and other structures (Kahler, 2000). Although the data on predator aggregation near piers are somewhat inconclusive, the fact that bass (especially smallmouth bass) thrive in lakes with developed shorelines while salmonids and other species decline suggests that predator species have an advantage over prey fish in structurally simple environments (Kahler, 2000).

Historically, docks and piers were constructed of chemically wood treated wood, which is a source of polycyclic aromatic hydrocarbons (PAHs) and heavy metals. These preservatives can leach into the water column and become toxic to aquatic organisms. The number of chemically-treated wood docks on Lake Sammamish is not known, and it is expected that most new docks are constructed using alternative, less harmful materials such as metal.

There are additional adverse effects associated with dock, pier, and bulkhead construction related to noise and pile driving. Noise and vibration caused by pile driving in marine environments has been shown to startle juvenile salmonids (Feist et al., 1996). These effects may also occur in lakes, although additional data on pile driving effects are needed.

Shore-spawning sockeye and kokanee salmon species in Lake Sammamish are especially susceptible to the construction of docks, piers, bulkheads (including skirted docks and piers) or any alterations that modify habitat structure, substrates, hydrology, water temperature, or water quality. Spawning areas can be degraded with sediment as scoured streambed material and fine sediment eroded from building sites and impervious surfaces are transported downstream to the lake. Vulnerable beach spawning areas include near-shore substrates that receive spring-fed upwelling, as well as alluvial fans at stream mouths.

5.0 SUMMARY OF SHORELINE MANAGEMENT ISSUES AND OPPORTUNITIES

The state shoreline Guidelines require local jurisdictions to identify general opportunities for shoreline protection, enhancement and restoration, and potential impediments to the protection and restoration of ecological functions[38]. In addition, local governments are required to analyze current and projected shoreline use patterns and potential use conflicts and identify current and potential future public access sites. This section summarizes overall protection, restoration and development potential at the watershed scale and describes specific management issues, use patterns and conflicts, restoration opportunities, and public access opportunities for each of the City's three shoreline areas.

5.1 Overall Protection, Restoration and Development Potential

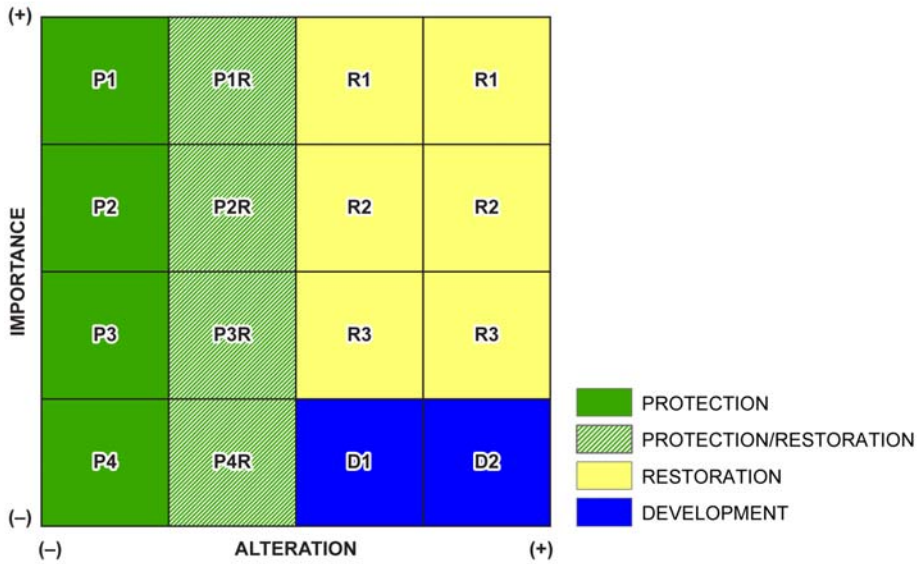
There are numerous opportunities to protect, restore, and enhance shorelines throughout Issaquah, including areas within and outside of shoreline jurisdiction. Many site-specific opportunities have been identified and discussed as part of past efforts including the 2003 Stream Inventory (Parametrix, 2003), and the Stream and Riparian Areas Restoration Plan (Watershed, 2006). Specific restoration opportunities and sites must be understood in the context of the watershed processes that shape and influence shoreline structure and function.

Ecology identified the important areas for ecosystem process and the level of alteration present in each subbasin within the study area (see Chapter 3). Ecology's analysis provides a framework for determining how development, protection and restoration could be prioritized throughout the watershed. The analysis combines the results of the Important Areas and Alterations mapping (Maps 31 and 32 in Appendix A) to create a relative ranking of where development, protection and restoration could occur at the watershed scale (Map 33 in Appendix A). As shown in Figure 5-1, areas with high importance and low alteration array towards 'Protection', while areas with high importance and alteration array toward 'Restoration.' Areas with low importance and high alteration array toward 'Development'.

The categories are not absolute or exclusionary, meaning that it is possible for Development to occur within a Protection area and for Restoration to occur in a Development area, and so forth, because within any subbasin there may be smaller areas that do not match the overall management recommendation. It is also important to note that the categories are not discreet but occur along a continuum from Protection (highest ecological value, least altered) to Development (lowest ecological value, most altered).

[38] The Guidelines also require a Restoration Plan, which will be prepared in a subsequent SMP update step.

Figure 5-1 Protection, Restoration, and Development Categories (Source: Ecology[39]



These results have the following general patterns in the landscape surrounding Issaquah (see Map 33 in Appendix A):

- Protection is focused in the higher elevation areas within the southeastern portion of the study area that are within the rain-on-snow zone.
- Protection/Restoration areas are mapped generally in the upper alluvial valley and in the upper North and East Forks.
- Restoration areas are distributed throughout the more urbanized portion of the study area, including the downtown core.
- Only four subbasins were identified in the Development category; all are located in the Laughing Jacobs basin.

These results highlight the most significant challenge to restoring ecosystem processes at the landscape scale – the areas that would benefit most from restoration are often the areas that are the most highly developed and therefore are the most constrained. While widespread restoration of ecological function is difficult in highly developed urban areas, these results underscore the importance of restoration efforts within a broader landscape context and support the City's policy of restoring the major stream channels. It will also be important to pursue restoration

[39] Numbers indicate relative importance within the category, i.e., P1 areas are the most important protection areas, followed by P2, P3….

opportunities on the terraces immediately above and to the east of downtown as these areas play an important role in supporting recharge and discharge to downstream aquatic resources.

Continuing to focus restoration efforts within the urban core will: (1) apply resources to the key areas within these subbasins designated as Restoration, and (2) allow for the preservation and enhancement of longitudinal connections through the landscape. Without a healthy lake and stream channels that function at a high level, the benefits of protecting the intact important areas in the upper watershed are not fully realized. Hence, effective shoreline management through the SMP and successful restoration of ecosystem processes throughout the watershed are equally important. By preserving and restoring Issaquah Creek and its tributaries, important connections between the upper watershed and Lake Sammamish will continue to occur, and can be made to function better over time.

The relative lack of subbasins identified within the Development category should not be interpreted as a blanket rejection of future development in other parts of the study area. Rather, this method indicates that restoration and protection efforts would be better applied elsewhere in the basin.

5.2 Reach-scale Management Summaries

5.2.1 Mainstem Issaquah Creek

5.2.1.1 Summary of Ecological Functions and Management Issues

Ecological functions and habitat conditions in the Mainstem Issaquah Creek are At Risk or Not Property Functioning (Parametrix, 2003). Urban development within the basin and in the shoreline planning area have impaired functions and degraded shoreline habitat. The inventory noted five primary factors driving the loss of functions: 1) lack of riparian vegetation, 2) lack of large woody debris, 3) lack of channel complexity, 4) high sediment loads, and 5) increased hydrologic disturbance.

The riparian corridor along the Mainstem has been significantly altered by urban development. The creek lacks significant woody debris needed for forming pools used by salmonid species for holding and rearing habitat. The lack of a well vegetated riparian corridor limits the ability of the stream to recruit new woody material over time. Lack of riparian vegetation also allows increased water temperature. Bank armoring and confinement have reduced channel complexity, concentrated flows, decreased floodplain connectivity, and caused higher flow velocity and water depths. Removing bank armoring to restore overbank flooding is one of the key measures to address “at risk” and “not properly functioning conditions.”

Most of these problems are concentrated in the lower reaches of the creek where urban density is most pronounced. Conditions in Lake Sammamish State Park and in the upper reaches of the Mainstem, where development is less intense and public open spaces are more common, are somewhat better. In these areas, bank conditions are more natural, the riparian corridor is more intact, and the floodplain remains more connected.

Based on these existing conditions, the important management issues for the Mainstem are:

- Preservation and enhancement of riparian vegetation using setbacks and buffers.
- Vegetation conservation standards.
- Bank stability and strategies to promote non-structural bank protection.
- Clearing, grading and impervious surfaces and their relationship to altered hydrology and sediment processes.

5.2.1.2 Future Use Patterns and Potential Use Conflicts

Current land use in the shoreline is dominated by commercial uses in the lower reaches and by low-density residential uses in the upper reaches. Transportation facilities (roads, bridges and freeways) comprise a significant land use throughout the Mainstem's length. All three of these uses have contributed to an overall increase in impervious surface (within the watershed and the city) and modification of the creek's bank, resulting in several conditions that negatively affect shoreline ecological functions and habitat quality.

In general, ecological conditions in the upper reaches are better than those in the lower reaches. This pattern is reflective of the difference in existing and planned land uses between the lower and upper reaches of the Mainstem. With some exceptions, the lower reaches of the Mainstem shoreline, which include the City's CBD, are largely built out. The relatively high level of shoreline development and bank modification in these areas will be a constraint to maintaining or improving ecological functions.

The shoreline areas in the upper reaches have more intact ecological functions. However, these areas (particularly Reaches G and H) have a substantial amount of land zoned and planned for low-density residential development. Development of these properties and its potential to alter intact shoreline vegetation, increase in impervious surface, or armor stream banks will be key issues for the SMP update. The SMP update should consider how to minimize the potential adverse effects that this development may have on shoreline functions.

5.2.1.3 Opportunities for Enhancing and/or Restoring Ecological Functions

The City of Issaquah has made significant strides in identifying specific stream and habitat restoration projects that address the factors currently limiting shoreline ecological functions and habitat quality. The 2003 Stream Inventory provides a range of potential stream improvement opportunities and recommends site- or reach-specific projects that may restore and enhance fish habitat and other stream functions. The City also developed a Stream and Riparian Areas Restoration Plan (Watershed, 2006), which identifies 74 potential restoration projects.

In general, enhancement and restoration efforts should focus on the processes and functions identified in this report. Table 5-1 provides an overview of general protection, enhancement and restoration opportunities for each reach (Parametrix, 2003). Specific opportunities will be described in more detail in the restoration plan, to be prepared at a later date.

Table 5-1 Summary of Protection, Enhancement and Restoration Opportunities for Mainstem Issaquah Creek

Opportunity	Reach							
	A	B	C	D	E	F	G	H
Riparian Enhancement	●		●	●	●		●	●
LWD placement	●	●	●	●	●	●	●	
Bank Stabilization/Repair	●			●			●	●
Culvert Repair								●
Off-channel Enhancement/Creation	●			●			●	●
Fish passage enhancement	●							
Public Land Acquisition	●						●	●
Community Outreach			●	●	●			●

Source: Stream Inventory and Habitat Evaluation Report (Parametrix, 2003)

5.2.1.4 Public Access Opportunities

As described in section 4.1.4.3, there are several existing parks and open spaces along the Mainstem Issaquah Creek that offer public access to the shoreline. Several of these are currently developed for public use; others are in various stages of planning. Through these ongoing planning efforts, the City has the opportunity to enhance public access at several locations along the Mainstem Issaquah Creek.

It is current City policy to acquire lands for future parks, trails and trail connections and natural open spaces (City of Issaquah, 2004b). The City's policies place a priority on acquiring areas that function as wildlife habitat; shoreline areas are uniquely valuable as wildlife habitat. Continuation of this policy should provide the City with future opportunities to provide public access to the shorelines.

Public access to the shoreline can also be provided from private commercial or industrial properties or through residential subdivision. The SMP update should consider methods to require or provide incentives to provide physical or visual access to the shoreline on private commercial or industrial developments.

5.2.2 East Fork Issaquah Creek

5.2.2.1 Summary of Ecological Functions and Management Issues

Conditions in the East Fork Issaquah Creek upper reaches (Z and ZZ) differ significantly from those of the lower reaches (X and Y) (See Maps 16 and 28 in Appendix A). The shoreline planning areas in the lower reaches have a high percentage of impervious surface due to past and recent urban development. As a result, the instream and riparian habitat areas are highly altered (Parametrix, 2003). The Stream Inventory also found that the lower reaches have a large proportion of armored shorelines and are highly channelized. The result is a lack of floodplain connection, a loss of off-channel habitats, and a lack of pool habitat. Riparian vegetation is highly altered. Banks in the lower reaches are often infested with Himalayan blackberry with limited riparian overstory and limited potential for recruitment of wood.

Conditions upstream (Reaches Z and ZZ) differ as commercial and residential development transitions to freeway structures and open space. As reported in the Stream Inventory, construction of the Sunset Way Interchange eliminated riparian vegetation, decreasing shaded areas and increasing habitat degradation (Parametrix, 2003). Habitat improves upstream of the interchange. However, the lack of LWD persists, which limits the formation of pools essential for fish habitat.

Based on these existing conditions, the important management issues for the East Fork are:

- Preservation and enhancement of riparian vegetation using setbacks and buffers.
- Vegetation conservation standards.
- Bank stability and strategies to promote non-structural bank protection. Removing bank armoring to restore overbank flooding is one of the key measures to address "at risk" and "not properly functioning conditions."
- Clearing, grading and impervious surfaces and their relationship to altered hydrology and sediment processes.

5.2.2.2 Future Use Patterns and Potential Use Conflicts

Current and planned land use in the lower East Fork reaches is dominated by urban development (commercial and residential). The upper reaches are dominated by I-90 and publicly owned natural open space (NRCA). In the upper reaches, the shoreline planning areas within the City (outside of the I-90 corridor) are almost completely within natural open space areas.

In the lower reaches of the East Fork Issaquah Creek (Reaches X and Y), future land uses and potential conflicts are similar to those described for the Mainstem Issaquah Creek. Urban development in both lower reaches has resulted in relatively high levels of shoreline armoring and habitat alterations. In Reach X, the relatively high level and type of existing and future shoreline development will present a limiting factor to maintaining or improving ecological functions. Maps 16 (Appendix A) shows the shoreline riparian conditions along the East Fork Issaquah Creek as catalogued in the Stream Inventory.

Current and planned land use in Reach Y is more extensively single family residential development. There are very few undeveloped properties in Reach Y. Reach Y also contains areas zoned for multi-family development that are currently underdeveloped with less intense uses than allowed in the zone. Potential future conflicts between land use and ecological functions are likely to arise from redevelopment of single family homes and more intensively developed multi-family areas. These types of development would have the potential to further alter shoreline vegetation and increase impervious surface in the shoreline. The SMP update should consider how to minimize the potential adverse effects that more intensive redevelopment could have in these reaches.

The upper portion of Reach Y and Reaches Z and ZZ are composed almost entirely of the I-90 corridor and Sunset Interchange (generally to the north) and the NRCA. Neither of those uses is expected to change in the future. The freeway and interchange will continue to represent a limiting factor to the health of the creek. The City will have limited ability to manage those areas.

5.2.2.3 Opportunities for Protecting, Enhancing and/or Restoring Ecological Functions

As described above for the Mainstem, protection, enhancement, and restoration efforts should be focused on the processes and functions identified in this report. They should also aim to achieve multiple functions that address, where possible, the SMA goals of ecological preservation, public access, and planning for appropriate shoreline use. The 2003 Stream Inventory provided an overview of general protection, enhancement and restoration opportunities in each reach (Reach ZZ was not included in the 2003 Inventory). Those opportunities are summarized below, in Table 5-2.

Table 5-2 Summary of Protection, Enhancement and Restoration Opportunities for East Fork Issaquah Creek

Opportunity	Reach			
	X	Y	Z	ZZ*
Riparian Enhancement	●	●		
LWD placement	●	●	●	●
Bank Stabilization/Repair		●		
Culvert Repair				
Off-channel Enhancement/Creation				
Fish passage enhancement				
Public Land Acquisition	●			
Community Outreach		●		

Source: Stream Inventory and Habitat Evaluation Report (Parametrix, 2003)

* Evaluation of Reach ZZ was not included in the 2003 Stream Inventory. Based on review of aerial photography and other available data sources, it appears that conditions in Reach ZZ are similar to those described for Reach Z.

The City's Stream Inventory and Habitat Evaluation Report (Parametrix, 2003) and the Stream and Riparian Areas Restoration Plan (Watershed, 2006) provide detailed information for numerous specific protection, enhancement and restoration projects.

5.2.2.4 Public Access Opportunities

As described in section 4.2.4.3, public access to the East Fork is relatively limited. The only City-owned property within the lower creek is the parks/facilities shop located at the southeast corner of the confluence of the East Fork and Mainstem. The property is programmed to be part of the Issaquah Creek and Cybil Madeline park site in the future. Implementation of this goal represents a significant opportunity to increase public access to the East Fork.

As described for the Mainstem, the City has a policy to acquire lands for future parks, trails and trail connections and natural open spaces (City of Issaquah, 2003). Acquisition would be one method of increasing public access opportunities in the East Fork shoreline.

Public access to the shoreline could also be provided from private commercial properties. The SMP update should consider methods to require or provide incentives to provide physical or visual access to the shoreline on private developments.

The NRCA provides limited access to the East Fork within City limits where the creek is not within the I-90 corridor. The City could consider enhancing access to the creek through trail development in the NRCA.

5.2.3 Lake Sammamish

5.2.3.1 Summary of Ecological Functions and Management Issues

Increased residential and commercial development, along with associated roadway infrastructure within the Issaquah Creek basin and along the lakeshore (particularly in Reaches Lk_Sam01 and Lk_Sam03), has impaired several key ecological functions of shoreline habitat with the Lake Sammamish shoreline.

Increased impervious surface in the shoreline as well as in upland areas has altered the intensity, timing, and duration of peak flows in many tributary streams, resulting in habitat impacts at the mouth of tributaries, both along the Mainstem of Issaquah Creek and along the lake shoreline. Habitat impacts include reduced fish access due to channel incision, blocked culverts, buried spawning habitat, and localized flooding and turbidity.

Water quality degradation is directly linked to the altered flow and sediment processes and to increases source inputs associated with urban land uses practices. Use of fertilizers for lawn maintenance along the lakeshore and in upland areas can trigger algal blooms during the summer, which could further decrease dissolve oxygen levels furthering, a limiting factor for salmon and other aquatic organisms.

Shoreline modifications are a significant concern along Lake Sammamish. The proliferation of residential docks, piers, and bulkheads along the lakeshore has reduced the quality and accessibility of rearing and migratory habitat for juvenile salmonids and other species. Much of the dense woody and emergent vegetation that once lined the Lake Sammamish shoreline has been replaced by structurally simple docks and piers causing a decrease in woody debris, overhanging vegetation, and detrital inputs.

In general, shoreline modifications that occur in the context of urban development create a suite of physical, biological and chemical responses. The following summarize the potential effects of bulkheads, piers and docks:

- Reduce primary productivity due to shading (docks);
- Alter predator-prey interactions in a manner that favors salmonid predators;

- Modify the physical configurations of the shore by disrupting sediment pathways, and causing erosion;
- Introduce toxic chemicals such as PAHs and heavy metals;
- Eliminate shallow water habitat which is an important migratory pathway for juvenile fish;
- Create construction noise and vibration, which can startle juvenile fish;
- Impact unmapped cultural resources, which are frequently found near lake and stream shorelines;
- Displace natural shoreline vegetation and reduce the organic inputs (terrestrial insects and detritus) to the lake; and
- Decrease shoreline habitat complexity due to loss of rootwads, overhanging vegetation and undercut banks.

Recreational use of Lake Sammamish creates additional challenges for maintaining ecological functions. Potential impacts include spreading exotic species of plants and plankton, noise impacts to fish and wildlife, increased wave energy and shoreline erosion, direct physical injury due to contact with people and watercraft, re-suspension of contaminated sediments and/or increased turbidity caused by propeller scour, and possible introduction of chemical pollutants from boat emissions.

Residential and associated shoreline modifications have the potential to impact cultural resources. These resources have typically been surveyed and mapped with higher frequency along the Lake Sammamish shoreline, and more generally along other lake and stream shorelines throughout the region.

Based on these existing conditions, the important management issues for Lake Sammamish are:

- Protection of water quality by limiting introduction of nutrients and other contaminants.
- Protection of remaining lakeshore vegetation.
- Protection of remaining sections of unarmored shoreline.
- Effective standards for docks and other overwater structures.

5.2.3.2 Future Use Patterns and Potential Use Conflicts

Lands within the City's Lake Sammamish shoreline planning area are largely developed. The future land use of the shoreline would not be expected to change dramatically. Land use in shoreline Reach Lk_Sam01 (Greenwood Point) is almost entirely single family residential. There are few undeveloped properties, particularly on parcels along the lake shore. Potential conflicts in this areas are likely to arise from residential redevelopments that may increase impervious surface, expand shoreline armoring or add new docks.

Lands in Reach Lk_Sam03 are zoned for single family and multi-family development. Some of the properties in this reach are undeveloped or underdeveloped. The parcels immediately north of Lake Sammamish State Park are zoned for single family development and are currently vacant (See Map 19 in Appendix A). These properties are likely to develop in the future, potentially affecting shoreline ecological functions by adding impervious surface or increasing shoreline armoring. One of the properties currently has a dock. The multi-family property in the reach has 16 condo units and is zoned multi-family – medium, which allows 14.52 units/acre. That property may have the potential to add units in the future. The SMP update will have to consider how to minimize adverse effects to shoreline ecological functions that could result from redevelopment activities.

Reach Lk_Sam02 is comprised almost entirely of Lake Sammamish State Park. The park is a PAA of the City, but is not currently within City limits. Land use within the park is unlikely to change dramatically in the future.

5.2.3.3 Opportunities for Ecological Restoration/Conservation

Enhancing natural shoreline vegetation and improving fish passage within tributary streams along the eastern shoreline of Lake Sammamish are among the most important restoration opportunities that currently exist within the shoreline planning area. Other opportunities include removing failing docks and bulkheads and/or replacing with softshore alternatives where possible.

Table 5-3 provides a summary of shoreline ecological functions for Lake Sammamish, causes of impairment, and the relative scale(s) at which impairments are occurring (e.g., watershed, basin City/PAA-wide, shoreline reach scale, or multiple scales). General or programmatic restoration and management opportunities to address impairments are also described.

Table 5-3. Summary of Shoreline Functions and Programmatic Restoration and Management Opportunities – Lake Sammamish

Shoreline Ecological Functions Affected	Condition and Causes of Impairment	Scale of Alterations	Programmatic Restoration and Management Opportunities
Hydrologic Hyporheic	Increased impervious area and increased stormwater runoff cause Summer low flows in the tributaries flowing to the lake shoreline	Basin scale	• Protect groundwater and natural surface water sources to the lake. Restore wetlands. • Minimize impervious surface especially in areas of high infiltration (e.g., upper reaches of the Main Stem and East Fork Issaquah Creek within the City).
Hydrologic Hyporheic Water quality	Water quality is at risk due to inputs from phosphorus and altered sediment delivery.	Basin scale Reach scale	• Encourage wise stewardship of shoreline properties to minimize inputs from lawns and other residential sources. • Implement BMPs to minimize erosion and sedimentation in upslope areas.
Water quality Biological functions	Decreased habitat diversity, habitat quality, and reduced large woody debris due to the lack of lakeshore vegetation and riparian structure.	Reach scale	• Provide/encourage native landscaping along the lakeshores, including forested riparian habitat wherever possible. • Promote development of natural in-water habitat structures such as downed trees/rootwads. • Minimize future removal of trees. • Educate property owners on the importance of the nearshore zone and general lakeside stewardship practices.

Shoreline Ecological Functions Affected	Condition and Causes of Impairment	Scale of Alterations	Programmatic Restoration and Management Opportunities
Hydrologic Riparian habitats Biological function	Docks, riprap and other hardshore armoring disrupt natural connections between the lake and riparian habitats and increase vulnerability of juvenile salmon to predation.	Reach scale	• Discourage bulkhead and dock construction and promote replacement of armoring with soft shore alternatives. • Replant riparian habitats using native trees and shrubs.
Hydrologic Water quality Riparian habitat	Increased surface water runoff from impervious surfaces delivers pollutants and sediment to the lake. Erosion and stream scouring caused by flash runoff from impervious surfaces.	Basin scale Reach scale	• Continue efforts in surface water quality improvement. • Manage, detain and treat stormwater discharging to the lake. • Coordinate with King County and adjacent cities to develop BMPs with existing property owners to reduce runoff and pollutant loading. • Protect and restore wetlands adjacent to the lake and in the upper basin that serve to improve water quality. • Target wetland restoration and mitigation in areas where they would provide water quality functions. • Encourage Low Impact Development and infiltration. • Retrofit existing roads to provide water quality treatment. • Limit the use of new septic systems.

With the exception of several large shoreline areas along Lake Sammamish State Park, nearly all riparian habitat on the southern shoreline of Lake Sammamish has been modified by single family residential development. The relatively intact shorelines within the park, which are located primarily around the mouths of Tibbetts Creek and Issaquah Creek, have no modifications in the form of docks or bulkheads and contain significant numbers of mature conifers and cottonwoods. Bald eagles routinely use these areas for nesting and perching.

Large stream and lake shoreline associated wetland complexes characterize these areas, and considerable shoreline cover in the form of woody debris and riparian vegetation is present, providing excellent habitat for juvenile Chinook salmon. Preservation of these shoreline areas is addressed in the *Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* (King County et al., 2005) as important for the recovery of Chinook salmon within the watershed

5.2.3.4 Public Access Opportunities

Nearly all of Reach Lk_Sam02 is publicly accessible. Lake Sammamish State Park offers approximately 6,900 feet of publicly accessible shoreline. The State Park also contains the only motorized boat launch on Lake Sammamish. Reach Lk_Sam02 contains two parks; Timberlake Park and Sammamish Cove Park (see section 4.3.4.3). Both parks offer shoreline access.

The remainder of the City's Lake Sammamish shoreline contains very limited public access. Shoreline properties are predominantly in private residential ownership. Opportunities for additional access would have to come from City acquisition, which would most likely not be cost effective given the existing access options.

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7.0 ACRONYMS

APE	Area of Potential Effects
B-IBI	Benthic Index Of Biotic Integrity
CAO	Critical Areas Ordinance
CARA	Critical Aquifer Recharge Area
CBD	Central Business District
cfs	Cubic Feet Per Second
DAHP	Department of Archeology and Historic Preservation
DO	Dissolved Oxygen
DPS	Distinct Population Segment
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESHB	Engrossed Substitute House Bill
ESU	Evolutionarily Significant Units
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
GMA	Growth Management Act
IMC	Issaquah Municipal Code
LIV	Lower Issaquah Valley
LWD	Large Woody Debris
MWD	Medium Woody Debris
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCA	Natural Resource Conservation Area

NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
OHWM	Ordinary High Water Mark
PAA	Potential Annexation Area
PAHs	Polychlorinated Aromatic Hydrocarbons
PEM	Palustrine Emergent Wetland
PFC	Properly Functioning Conditions
PFO	Palustrine Forested Wetland
PHS	Priority Habitats And Species
PSS	Palustrine Scrub/Shrub Wetland
RCW	Revised Code of Washington
RM	River Mile
SED	Shoreline Environment Designation
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SPA	Shoreline Planning Area
SRFB	Salmon Recovery Funding Board
SSB	Substitute Senate Bill
SWM	Surface Water Management
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediment
TSI	Trophic State Index
UNOS	Urban Natural Open Space
USACE	Unites States Army Corps of Engineers
USBEM	Urban Stream Baseline Evaluation Method

USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish ad Wildlife
WDNR	Washington Department of Natural Resources
WHR	Washington's Historic Register
WRIA	Water Resource Inventory Area

Appendix A – Shoreline Inventory Maps

(Under Separate Cover)

1- Shoreline Planning Area
2 - Regional Context
3 - Topography and Hydrology
4 - Geology
5 - Soils
6 - Geologic Hazards
7 - Fish and Wildlife Habitat
8 - Riparian and In-stream Conditions
9 - Comprehensive Plan Land Use Designations
10 - Zoning and Public Access Sites
11 - Land Cover
12 - Impervious Surface
13 - Transportation and Utilities
14 - Parks, Open Space, and Public Access
15 - Hydrology Important Areas
16 - Hydrology Level of Alteration
17 - Protection and Restoration Areas
18 - Lake Sammamish Shoreline Modification Analysis

Shoreline Inventory and Characterization Map List

Map Title	Scale	Map No.
Shoreline Planning Area	City	1
Regional Context	Region	2
Topography and Hydrology	City	3
Geology	City	4
Soils	City	5
Geologic Hazards	City	6
Fish and Wildlife Habitat	Reach	7 – 11
Riparian and In-stream Conditions	Reach	12 - 16
Comprehensive Plan Land Use Designations	City	17
Zoning and Public Access Sites	Reach	18 - 22
Land Cover	City	23
Impervious Surface	Reach	24 - 28
Transportation and Utilities	City	29
Parks, Open Space, and Public Access	City	30
Hydrology Important Areas	Regional	31
Hydrology Level of Alteration	Regional	32
Protection and Restoration Areas	Regional	33
Lake Sammamish Shoreline Modification Analysis	Reach	34 - 36

Appendix B – Ecosystem Processes

Climate, geology and soils, and topography govern the patterns of surface and groundwater flow between upland and aquatic areas. The movement of water underlies most of the other processes that occur in a watershed and these same hydrogeologic characteristics play a major role in how sediment, nutrients, pathogens, and organic material (large woody debris) move within the watershed (Stanley et al., 2005). When human activities change the physical characteristics of the watershed, the manner in which ecosystem processes occur is altered.

This Appendix identifies areas of the watershed that are important for each process and describes locations where human activities have impaired key processes. Important areas that are unimpaired are potential areas for protection. Important areas that are impaired are potential areas for restoration[40].

Hydrology

In natural systems, the movement and storage of water is controlled by physical conditions such as climate (precipitation patterns and volumes), topography (gradient), land cover (vegetation) and the permeability or infiltration capacity of soils, and the underlying surficial geology (Figure B-1).

Ideally the amount, timing, and routing of water in and through a watershed is sufficient to maintain stream flows for fish and other species; support wetlands and wetland dependent wildlife species; recharge groundwater aquifers; and supply freshwater to downstream receiving bodies (e.g., Lake Sammamish, Puget Sound). As development occurs, patterns of natural infiltration and runoff become altered, often resulting in increased flooding, streambed scouring, stream channel and shoreline erosion, reduced aquifer recharge, low summer stream flows, loss of wetlands and other adverse impacts. To maintain healthy shorelines, it important to protect areas that store water (e.g., wetlands) and areas where groundwater recharge and discharge occur.

Water naturally enters the Lake Sammamish watershed mainly as rain or snow. The local climate is characterized by mild, wet fall to spring months, and cool dry summer months. Measured annual precipitation for the Issaquah Basin is between 30 to 70 inches, based on data from 1988 to 2001 (Golder, 2003). Precipitation typically occurs as low-intensity, long-duration storms (NCDC, undated) but can exhibit significant spatial variability (Golder, 2003). Precipitation levels can be much higher in the upper portions of the Issaquah Creek drainage than in the lowlands, with annual rainfall at higher elevations exceeding 100 inches in some years (Kerwin, 2001).

[40] Restoration areas will be described in more detail in the Restoration Plan, to be prepared at a later date.

Precipitation as snow is relatively rare and short-lived in the lowlands. However, hydrologic systems in the Pacific Northwest are especially sensitive to warm rain-on-snow events, when significant volumes of water can be released into the system at one time. In Issaquah, precipitation appears to be the primary driver of runoff patterns, as shown in the monthly average flows recorded by USGS gauges on Issaquah Creek at Hobart and at the mouth (Figure B-2). At the monthly scale, no snowmelt signature is apparent. Rain on snow events occur in this basin and can dramatically alter the hydrograph, but these events are somewhat rare as the vast majority of the basin occurs at low elevation.

Figure B-1. The Hydrologic Cycle (Source: Stanley et al., 2005)

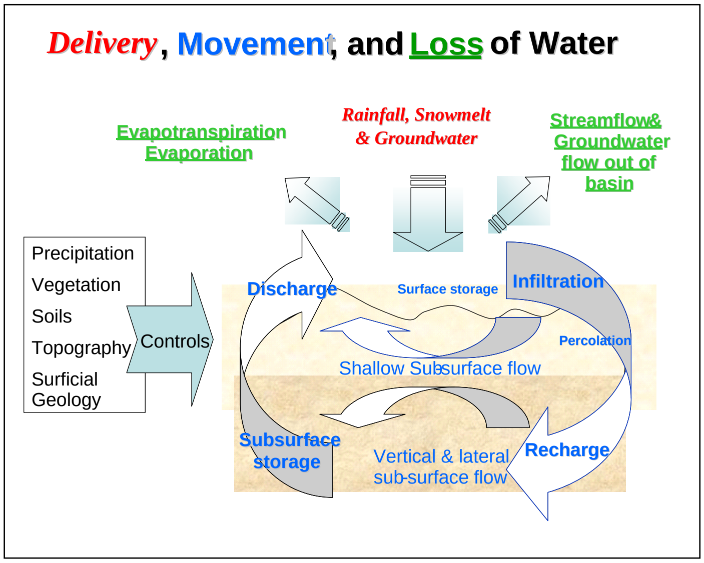
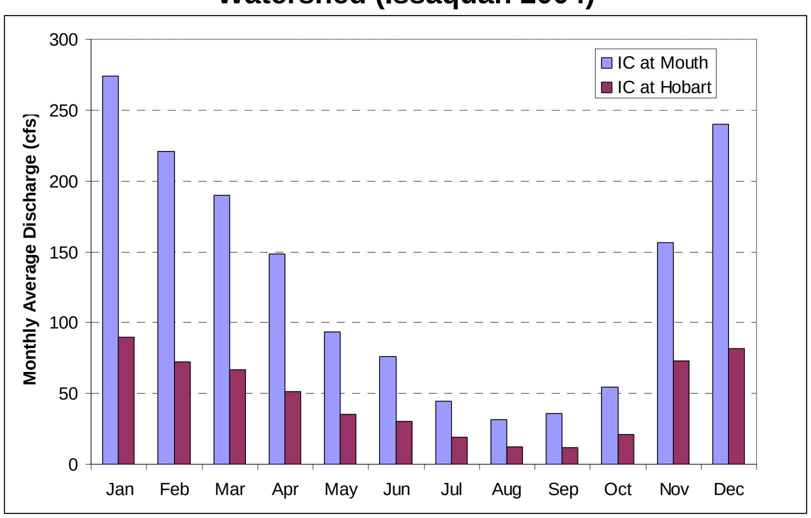


Figure B-2. Monthly Average Discharges from USGS Gauges in the Issaquah Creek Watershed (Issaquah 2004)



Once water enters the watershed, it moves as surface water in rivers and streams, infiltrates and becomes groundwater, or is stored in wetlands, lakes, and floodplains. The relationship between rainfall and surface runoff is critical to health of shorelines and other aquatic systems. In Issaquah, runoff patterns have been modified as a result of land cover changes, but while peak flows have increased, the increases are less than 10 percent when compared to a modeled forested condition (City of Issaquah, 2004a). Significant forest cover remaining in the upper basin and the presence of shallow bedrock through much of the basin limit the potential for significant increases in peak flows.

While increases in peak flows have been relatively limited, flooding is an ongoing issue within the City of Issaquah. Flooding issues result from: (1) development within the floodplain, (2) reduced channel capacity due to sedimentation, (3) increased peak flows, and/or (4) increases in storm intensity (City of Issaquah, 2004a). Stream channelization also contributes to flooding, especially where old berms or dikes line the channel banks. Existing estimated peak flows for different recurrence intervals are presented in Table B-1.

Table B-7-1 Peak flow estimates for streams within Issaquah

Stream and Location	Drainage Area (sq mi)	Peak Discharge (cfs)[a]			
		10-Year	50-Year	100-Year	500-Year
Issaquah Creek at Mouth	56.6	2,820	4,140	4,670	5,890
East Fork Issaquah Creek	9.5	560	900	1,050	--
North Fork Issaquah Creek	4.8	176	269	315	445
East Fork Issaquah Creek	9.5	440	725	850	1,100
Tibbetts Creek at Mouth	3.9	330	460	520	670

Source: City of Issaquah Stormwater Management Plan (2004a). Note: entries for East Fork reflect different data sets and different data collection timeframes.

Water can also infiltrate and flow in the subsurface as groundwater. Local groundwater recharge and discharge patterns are largely a function of topography and near-surface geology. The topography and near-surface geology near Issaquah are largely the product of the last glaciation (known as the Vashon Stade of the Fraser glaciation), which receded from the area about 13,500 years ago. As the ice sheet retreated, it deposited glacial drift on the expansive upland plains. The upland is largely mantled by lodgment till, which is partially buried by recessional sand and gravel deposits across much of the upland. Lodgment till typically has very low permeability and acts to restrict the downward flow of groundwater and reduce recharge of deeper aquifers.

Recessional outwash and recessional lacustrine (lake) deposits of variable thickness commonly overlie till in the upland plain on the eastern portion of the City. These sediments were deposited in topographic low areas in the till surface where melt water streams drained from the receding glacier. Recent peat and muck deposits have accumulated on top of these poorly drained recessional lake deposits or on top of recessional outwash deposits, where downward percolation of groundwater is impeded by the presence of till at shallow depths beneath the outwash (Turney et al., 1995). These areas of peat and muck deposits are the sites of the largest, most rare, and often most ecologically valuable wetlands within the watershed.

Underlying the till on the glacial upland are thick deposits of sand and gravel separated by finer grained layers of clay and silt or tight, well-graded soils, such as till. These layers comprise several aquifers and aquitards within the subsurface and control subsurface water movement to Lake Sammamish and to the deeper river valleys that border the northeastern and southeastern sides of the Sammamish Plateau (Turney et al., 1995).

The transition from the alluvial valley to the surrounding upland plateaus is sharp as the upland plateau is typically more than 300 feet above the valley floor. The slopes that connect the plateau with the alluvial valley are dissected by many relatively high gradient first and second order stream channels.

Groundwater recharge can be significant and rapid in areas of recessional outwash, or can be very low in areas where bedrock is either exposed, or is close to the soil surface. In general, groundwater recharge dominates in the upland, while groundwater discharge dominates in the alluvial valley, and at the basin to lake interface.

Sediment Generation and Transport

The processes that govern the production, storage, and transport of sediment play a significant role in shaping the morphology and functioning of rivers and lakes. In natural systems, sediment is delivered via overland flow, mass wasting (e.g., landslides), and channel migration (e.g., eroding the outside of a meander bend) (Stanley et al., 2005). The relative importance of the sediment generation and transport pathways is typically a function of climate, topography, geology, vegetation, and soils.

Within the Issaquah Creek Basin urban land uses account for only 18 % of the basin area. The main sources of sediment in the basin are landslides (50%), channel-bank erosion (20%), and road surface erosion (15%) (Nelson, undated). Urban land uses and are not a major contributor to the sediment budget because developed areas do not generate significant sediment and only a relatively small fraction of the basin is under construction at any given time (Nelson, undated). However, sediment input has been affected by land use actions such as logging, clearing, and development in subbasins such as No Name Creek, Nudist Camp Creek, McDonald Creek, an unnumbered Mirrormont tributary, and Carey Creek (Parametrix, 2003).

Stream channel erosion is a major source of sediment in the Issaquah Basin. As discussed in the hydrology section, increased runoff patterns due to land use and cover changes can erode streambed and banks causing downcutting. At the same time increased sediment loads from upland areas can cause channel bed aggradation, which reduces the capacity of the channels to transport flows and exacerbates flooding. Sediment supply from the upper watershed and deposition along the channel varies annually and over a longer time frame depending on the occurrence of large landslides or a major bank erosion events. The sediment moves down the channel, raising and lowering the bed level as the sediment washes downstream. Channel migration and jumping typically increase as the larger sediment supply is washed down the valley (Parametrix, 2003) . Most of the deposition in the Mainstem Issaquah Creek appears to be related to localized constrictions or encroachment into the channel floodway such as low bridges or very narrow valley segments. The pinch points create backwaters to the flow during floods that lead to upstream and downstream bar deposition.

Sediment deposited at the downstream reaches or at the stream mouth not only leads to flooding but can affect habitat, and/or create barriers to upstream fish passage. Increased sediment inputs also have direct effects on water quality, particularly phosphorus loading in Lake Sammamish, since sediments are a major transport medium for phosphorus.

Table B-2 contains a summary of the important areas for sediment and their alterations.

Table B-7-2 Summary of Important Areas and Alterations – Sediment Processes

	Important Areas	Alterations
Soil Erosion	Northern portion of the MacDonald Creek subbasin, extending north into upper portion of the subbasins of small tributary streams draining the northern and northeastern slopes of Squak Mountain. The Fifteen Mile Creek subbasin and the Holder Creek subbasin, extending across much of the eastern Issaquah Creek basin (through the Tiger Mountain area). This area extends south from the I-90 corridor, east of the eastern edge of the Issaquah Creek valley, across the Highway 18 corridor to the southern extent of the Issaquah Creek Basin. The northern portion of the East Fork Issaquah Creek subbasin, extending north from the I-90 corridor approximately one mile upstream of the East Fork and Main Stem Issaquah Creek convergences. Narrow corridors in proximity to Mainstem Issaquah Creek, to the SW and NE of Issaquah-Hobart Rd. SE between Cedar Grove Rd SE and Highway 18.	Important areas in upper basin are not highly altered except near southern City limits where urban development is more prevalent. Road construction occurs throughout basin, mainly in the UGA. Channel migration could occur in lower reaches on Mainstem.
Landslides	Areas to the north, east, and west of Tradition and Round Lakes, along the I-90 corridor. These mapped landslide hazard areas are associated with East Fork Issaquah Creek. Areas associated with tributaries to Mainstem Issaquah Creek along the central reach. This area, where Issaquah Creek passes between the Squak Mountain and Tiger Mountain areas, has several tributary drainages. The most significant landslide hazard mapping is associated with the MacDonald Creek subbasin. In all cases, mapping is associated with tributary stream riparian corridors. Area associated with the Holder Creek riparian corridor, approximately 1.5 miles upstream of the convergence with Issaquah Creek.	Natural landslides are a primary sediment source. Limited urbanization in the upper basin means that important areas are not highly altered. Landslide prone areas near I-90 northwest of Lake Tradition are very altered.

Water Quality

The quality of the water in the streams, wetlands, and lakes is the result of the interaction of water with biota, soils, and urban and rural land use and infrastructure. Ecosystem processes that impact the source, concentration, and transport of mineral and organic constituents are: biotic uptake (e.g., plant growth), decomposition (e.g., plant death), adsorption (e.g., chemical binding), and dissolution (e.g., chemical unbinding). In general, elements cycle between dissolved and particulate forms in water to plants, animals, and soils; and back to the water column via decomposition. Buildup and washoff of pollutants presents a significant challenge to protecting water quality in urbanized systems.

Water quality contaminants of concern include nutrients, such as phosphorus and nitrogen, toxins, and pathogens such as bacteria, protozoans, and viruses. High levels of dissolved phosphorus and/or nitrate can cause excessive plant growth which leads to problems such as eutrophication and algal blooms. Nutrient inputs are a key concern in Lake Sammamish. Total phosphorus levels have tended to range from about 13 to 22 µg/L mean annual volume weighted total phosphorus per calendar year, which meets the target threshold. Although Lake Sammamish meets water quality standards for phosphorus, the lake is at risk for several other water quality parameters. Currently, Lake Sammamish is on Ecology's 303(d) list, as a Category 5 waterbody for ammonia N, dissolved oxygen, and fecal coliform

High levels of pathogens are an indication of potential fecal coliform contamination. Toxins include various chemicals that can be harmful to humans and animals at varying levels of exposure and concentration.

Dissolved phosphorus, which is the most biologically available form of phosphorus, moves through the watershed in surface or sub-surface runoff. Therefore, areas that provide phosphorus removal are important areas from a water quality perspective.

Phosphorus can be removed from water as it percolates through the soil or is adsorbed to fine soil particles such as clays. As a result, important areas for phosphorus removal include depressional wetlands and areas of clay soils. Clay soils are not widespread in the Issaquah Creek basin (http://websoilsurvey.nrcs.usda.gov/app/).

Nitrogen removal occurs as oxidized forms of nitrogen are reduced to gaseous nitrogen. This denitrification process takes place in some wetlands, lakes, and lowland riparian environments. Therefore, areas of a watershed that have a higher total percentage of wetland and riparian areas relative to other subbasins are important areas for nitrogen removal.

Fecal coliform bacteria are often present in high concentrations in streams and lakes downstream of areas with high concentrations of septic systems, high levels of urbanization or dairy farming. Stream channelization, paving, and filling/draining of wetlands can increase the rate that fecal coliform bacteria are transported through a watershed. Pathogens are removed through adsorption, filtration by vegetation, movement through soils and through death of the organisms. These processes occur where surface waters are slowed (depressional wetlands and riparian areas) or infiltrated (permeable soils). Therefore, subbasins with low-gradient streams and/or a high percentage of wetlands are important pathogen removal areas; these areas can also provide a very effective network for the movement of pathogens if they are channelized and drained.

Most residents in the basin are hooked up to municipal sewage systems but there are approximately 2,000 households (mainly unincorporated areas) in the basin that use on-site sewage disposal systems (Laboo, 2005). In addition, bacteria in pet waste, rural livestock, and urban wildlife washes into streams and lakes via stormwater runoff. Runoff and drainage from hobby farms is also a potential source of pathogens, although agricultural use in the basin is not widespread.

Table B-3 contains a summary of the important areas for water quality and their alterations.

Table B-7-3 Summary of Important Areas and Alterations – Water Quality Processes

	Important Areas	Alterations
Phosphorus, nitrogen removal	The upper portion of the Issaquah Creek basin, in the low-lying areas surrounding Four Lakes and Webster Lake. Also in the southern (upper) portion of the basin, there are a series of wetlands mapped along the 276th Ave. SE corridor near Highway 18. Wetlands are mapped extensively at the mouth of Issaquah Creek, in and around Lake Sammamish State Park.	Limited development in the upper basin, so wetlands are not highly altered. Wetland losses are more prevalent in lower basin and in the UGA. Wetlands at the mouth (Lake Sammamish State Park) are mostly intact. Stream channelization and floodplain development is prevalent in the lower basin.
Pathogen removal	Depressional wetlands noted above and permeable outwash deposits located on Mainstem valley slopes upstream of Issaquah, near eastern city limits, and in northeast corner of the basin.	Extensive development within floodplain throughout lower basin and the UGA.

Organic Materials

Organic materials refer to living plants, downed wood, detritus, as well as algae that develop and decompose in a watershed.

Downed trees play a significant role in the aquatic ecosystems of the Pacific Northwest. LWD significantly influences the geomorphic form and ecological functioning of riverine ecosystems (Maser et al., 1988; Nakamura and Swanson, 1993; Collins and Montgomery, 2002; Abbe and Montgomery, 1996; Collins et al., 2002; Montgomery et al., 2003a; Montgomery et al., 2003b). LWD consists of logs or trees that have fallen into a river or stream. In a natural system, LWD provides organic material to aquatic ecosystems and is considered a principal factor in forming stream structure and associated habitat characteristics (e.g., pools and riffles). Riparian vegetation is the key source of LWD. LWD is primarily delivered to rivers, streams, or wetlands by mass wasting (landslide events that carry trees and vegetation as well as sediment), windthrow (trees, branches, or vegetation blown into a stream or river), or bank erosion (Stanley et al., 2005). Riparian areas are the important areas for LWD recruitment. These areas have been fairly extensively altered by urban development except for in the upper basin. The lack of conifer trees--and mature forested riparian vegetation in general --along Issaquah Creek and the East Fork contribute to a lack of persistent LWD in these systems.

Appendix C – Shoreline Use and Public Access Analysis

Introduction

This technical memorandum (tech memo) has been prepared consistent with the Shoreline Master Program Guidelines (WAC 173-26-201(3)(d)) and task 3.1.4 of the consultant scope of work. Its purpose is to summarize the findings of the Shoreline Inventory and Characterization Report (ESA Adolfson, 2008) as they pertain to shoreline uses and potential conflicts (WAC 173-26-201(3)(d)(ii)) as well as shoreline public access needs and opportunities (WAC 173-26-201(3)(d)(v)) within the City of Issaquah's shoreline planning area (SPA). The tech memo presents summary descriptions of current and future shoreline uses and potential conflicts. The memo also includes a summary of existing and planned public shoreline access opportunities.

Shoreline Use Analysis

Current Shoreline Use

Current shoreline uses in the City were identified based on a review of land use categories in the King County assessor's data and information from city staff. The City of Issaquah's shoreline land use pattern is relatively similar to the pattern in the City as a whole; a mix of residential (primarily low and moderate density), commercial (primarily in the downtown area), and open space. The lower reaches of the Mainstem Issaquah Creek shoreline (outside of Lake Sammamish State Park) are largely developed with urban uses. Current shoreline use along the Mainstem (outside the State Park) is dominated by commercial uses in the lower reaches (A, B, and C) and low-density residential uses and vacant lands in the upper reaches (G and H). Similarly, shoreline uses along the lower reaches (X and Y) of the East Fork are dominated by commercial and residential uses. The upper reaches are dominated by the I-90 corridor and publicly owned natural open space (Natural Resource Conservation Areas). Transportation facilities (roads, bridges and freeways) comprise a significant proportion of the shorelands along both the Mainstem and East Fork. The City's Lake Sammamish shoreline (outside of the State Park) is largely developed with residential uses.

Water-oriented Uses

Water-oriented uses, as defined by WAC 173-26-020, are scare in Issaquah. There are currently only two uses in the SPA that are water-dependent: the WDFW Issaquah Fish Hatchery (Issaquah Creek Reach F) and the public boat launch in the Lake Sammamish shoreline (Reach Lk_Sam03). According to King County assessor's data, there are only three properties in the Mainstem and East Fork shoreline planning areas classified as industrial (although there is no Industrial zoning Issaquah, only Intensive Commercial) and approximately 40 properties (17 of which are in Reach C) are classified as commercial or retail. None of these properties appears to be water-dependent or water-related.

The lack of water-dependent/water-related uses in the City reflects the absence of any significant maritime industry in Issaquah and the physical characteristics of the City's SMA waterbodies. There are limited opportunities for water-dependent and -related uses in the City's shoreline planning area because the creeks are too small to support water transport, marina development, or water-oriented commercial or industrial operations such as boat yards, boat repair, or commercial fishing. Also, the established pattern of single-family development (which is a considered a preferred use under SMA), retail areas and open space along the Mainstem and the East Fork shorelines is generally incompatible with the types of large-scale uses typically considered water-dependent or –related. Opportunities for water-dependent and –related uses along the lakeshore are also limited because of the existing land use pattern (predominantly single-family development and state- and city-owned park land).

While water-dependent and –related uses are limited in the shorelines, some of the current uses in the shoreline qualify as water-enjoyment. These include public parks and open spaces. Water-enjoyment uses could include restaurants or other businesses that offer the formal or informal public visual or physical access to the creek. Currently, the majority of commercial properties in the creek shoreline do not offer public shoreline access. There is one restaurant located along Gilman Boulevard with a shoreline location that has windows providing visual access to the Mainstem Issaquah Creek shoreline (Rosen, 2008). Some shoreline sites may offer informal access to the shoreline that are not official or developed water access facilities.

Future Land Use and Trends

The future land use pattern in the SPA is determined primarily by the City's Comprehensive Plan (City of Issaquah, 2004). The Comprehensive Plan establishes the City's desired future land use pattern and provides an overall vision for growth and development for areas inside and outside shoreline jurisdiction. The Comprehensive Plan's was designed to accommodate the City's share of projected new housing and jobs (3,993 units and 14,000 jobs by 2022) in accordance with the Growth Management Act (GMA).

The City's zoning code (Issaquah Municipal Code [IMC] Title 18) is primarily responsible for implementing the Comprehensive Plan. Various other sections of the IMC including environmental policy (IMC18.10.010 through 18.10.330) and stormwater management (IMC 13.28) also play a major role in how shorelines can and will be developed. Zoning and Comprehensive Land use designations are shown in Inventory and Characterization Report Maps 17 through 22.

The City's Lake Sammamish shoreline and the lower reaches of the SMA creeks are largely built-out in a fashion that is generally consistent with the Comprehensive Plan. According to the Comprehensive Plan, the City is expected to grow from a 2007 population of 24,710 to 29,199 by 2022. Growth in population and jobs is likely to cause new residential and commercial development. Some of this growth will be attributed to the Issaquah Highlands, Talus, and future annexations, but some of the growth is likely to occur within the existing City limits and SPA. Because the lower reaches of the creeks are largely developed in accordance with the Comprehensive Plan, redevelopment is likely, but major changes in the land use type, density, or intensity are not.

Future use changes in the shoreline are likely to occur in the upper reaches of Mainstem Issaquah Creek. A review of King County assessors' data indicates that there is a substantial amount of land classified as vacant in Reaches G (26 percent) and H (54 percent). Of these lands large areas are planned and zoned for residential uses (mostly SF-S - Single-family Suburban - 4.5 dwelling units/acre in Reach H and SF-SL - Single-family Small Lot – 7.26 dwelling units/acre in Reach G). As the City's population grows, these lands are likely to develop, consistent with the city zoning, as varying densities of residential uses. Smaller scale use changes may also occur in Reach Y, where there are properties zoned for multi-family development that are currently underdeveloped. The City has also acquired several residential properties in the SPA that will become parks or public open spaces.

Demand for future water-dependent and water-related uses other than parks/open space (and some associated water-oriented recreation) appears to be low. The City does not anticipate a demand for any new water-dependent/-related industries or commercial developments and has not provided for such in the Comprehensive Plan or zoning code. This appears consistent with the physical limitations of the City's' SMA water bodies and the historically low demand for these uses in Issaquah. The possibility for future expansion of private water-enjoyment uses, such as restaurants, is present. There is are sizeable areas of commercial zoning on Mainstem Issaquah Creek, particularly in the downtown area, which could be redeveloped to restaurants or other commercial uses that could provide views of the creek or outdoor seating near the creek.

Potential Conflicts

The state's shoreline guidelines recognize that there are numerous competing and often conflicting uses of the shorelines. To avoid use conflicts and allow appropriate development in the shoreline, the guidelines establish a hierarchy of preferred uses (WAC 173-26-201(2)(d)) giving priority as listed below:

1. Areas for protecting and restoring ecological functions to control pollution and prevent damage to the natural environment and public health.

2. Areas for water-dependent and associated water-related uses.

3. Areas for other water-related and water-enjoyment uses that are compatible with ecological protection and restoration objectives.

4. Single-family residential uses, where they are appropriate and can be developed without significant impact to ecological functions or displacement of water-dependent uses.

5. Non-water-oriented uses limited to those locations where the above described uses are inappropriate or where non-water-oriented uses demonstrably contribute to the objectives of the Shoreline Management Act.

In the context of this memo, use conflicts are discussed in terms of the existing or future land use pattern prohibiting or limiting preferred uses as defined in the guidelines. As discussed above, water-dependent and water-related uses are not likely to develop in the City's shoreline. The primary use conflicts facing the City will be providing for protection and/or restoration of shoreline ecological functions in already built-out shorelines and allowing additional residential development/redevelopment in a manner that does not adversely affect shoreline ecological functions.

With some exceptions, the lower reaches of the Mainstem and East Fork shorelines, which include the City's downtown business core, are largely built-out. The relatively high level of shoreline development and bank modification in these areas represent a potential constraint to uses that would protect or restore ecological functions. But, it is possible for future development and redevelopment to include protection or restoration elements in compliance with the guidelines' use preferences.

The shoreline areas in the upper Mainstem and East Fork reaches have more intact ecological functions. However, these areas (particularly Reaches G and H of the Mainstem) have a substantial amount of land zoned and planned for low-density residential development. Development of these properties has potential to alter intact shoreline vegetation, increase in impervious surface, or armor stream banks, which will be key issues for the SMP update. While residential development is a preferred use, the SMP update should consider how to accommodate it in a manner that minimizes potential adverse to shoreline ecological functions (consistent with #4, above).

The upper portion of the East Fork Reach Y and Reaches Z and ZZ are composed almost entirely of the I-90 corridor and Sunset Interchange (generally to the north) and the NRCA. Neither of those uses is expected to change in the future. The freeway and interchange will continue to represent a potential threat to the health of the creek and a barrier to restoring shoreline ecological functions. The City will have limited ability to manage these shoreline areas, occupied by roadways, through the SMP policies and regulations because of their existing public infrastructure uses.

Lands within the City's Lake Sammamish shoreline planning area are largely developed. The future land use of the lake shore is not expected to change dramatically. Land use in shoreline Reach Lk_Sam01 (Greenwood Point) and Lk_Sam03 are almost entirely single-family residential. According to King County assessors' data, there are few only four properties classified as vacant within shoreline Reaches Lk_Sam01 and Lk_Sam03.

Lands in Reach Lk_Sam03 are zoned for single-family and multi-family development. Some of the properties in this reach are undeveloped or underdeveloped. These properties are likely to develop in the future, potentially affecting shoreline ecological functions. Potential conflicts in this area are likely to arise from residential redevelopments that may have adverse impacts to shoreline ecological functions. Shoreline armoring, overwater-structures, and clearing of shoreline vegetation will be key concerns in this area.

Public Access Analysis

The shoreline guidelines require that the City analyze shoreline public access needs and opportunities and explore actions to enhance shoreline recreational facilities (WAC 173-26-201(3)(d)(v)). The City of Issaquah has a relatively large amount of public park land that offers both visual and physical access to the City's SMA shorelines. Parks and open spaces that are adjacent to or partially within the SPA encompass approximately 711 acres (198 acres excluding Lake Sammamish State Park).

There are also several public trails within the City. Of those, the Pickering Trail and the Hatchery Dam Trail are within the SPA. The Pickering Trail is a multiple use trail that extends approximately three-quarters (3/4) of a mile south from Pickering Farm (Reach A) along Issaquah Creek to Emily Darst Park, where it links to the East Lake Sammamish Regional Trail (Reach B). The Hatchery Dam Trail (Reach G) extends south from Mine Hill Park along the eastern shore of Issaquah Creek.

The City plans to study the feasibility of a comprehensive trail system along the Mainstem Issaquah Creek shoreline in the near future. Establishing a connected trail along the entire shoreline will be difficult and costly because substantial areas of the shoreline are privately owned and developed. This is particularly true of the central business area. There appear to be fewer potential impediments to establishing sections of a connected trail system in the areas north and south of the downtown area, where the shorelines are less constrained by existing development. The feasibility study would have to consider the existing development pattern, the availability of land and/or easements, and the concerns of property owners.

The City's Parks, Recreation, Trails and Open Space Plan assessed parks and recreation needs and opportunities throughout Issaquah (City of Issaquah 2003; amended in 2004). The Plan establishes goals, objectives, and policies to achieve those needs; and includes a capitol improvement plan to implement the goals and policies. Table 1 describes all of the parks and open spaces that are within or partially within the SPA. The table identifies the current size of the park, amenities, and the park's status. Several properties have been acquired since the 2003 Parks, Recreation, Trails and Open Space Plan was prepared. Available information on those sites is presented here as well.

Table 4 Public Parks and Open Spaces in the City of Issaquah Shoreline Planning Area

Shoreline Reach	Park Name	Characteristics/Facilities		Type of Public Access[1]	Status[2]
		Size (Acres)	Characteristics		
Lk_SAM01	Timberlake Park	23.0	Play field; parking lot; picnic tables; trails; non-motorized boat launch; beach access	P, V	Owned and managed by City of Issaquah; developed.
Lk_SAM01	Sammamish Cove Park	20.0	Undeveloped meadow	P, V	Owned and managed by City for preservation of open space/wildlife habitat; contains no facilities.
Lk_SAM02	Lake Sammamish State Park	512.0	6,900 feet of publicly accessible shoreline; swimming beaches; motorized boat launch; natural open spaces with trails; parking	P, V	Redevelopment and Restoration Concept Plan adopted by the Washington State Parks and Recreation Commission August, 2007.
Issaquah Creek A	Parcel 2124069101	9.9	No developed park facilities	P, V	City-owned; no new development currently planned.
Issaquah Creek A	Pickering Farm	9.0	Pickering barn; community teaching garden; public market	P, V	Carriage house renovation is a long term goal (2003 – 2022).

Table 1 Continued

Shoreline Reach	Park Name	Characteristics/Facilities		Type of Public Access[1]	Status[2]
		Size (Acres)	Characteristics		
Issaquah Creek B	Emily Darst Park	12.0	Undeveloped wetlands; traversed by Pickering Trail	P, V	Passive park development is a long term goal (2003 – 2022).
Issaquah Creek D	Berntsen Park	2.3	No developed park facilities	P, V	Recently acquired by city; undeveloped. Currently riparian preservation/open space.
Issaquah Creek D	Cybil Madeline Park	5.5	No developed park facilities	P, V	Park development is a short term goal (2003 – 2012).
Issaquah Creek D	Issaquah Creek Park;	4.5	No developed park facilities	P, V	Park development is a short term goal (2003 – 2012).
Issaquah Creek D	Tollë Anderson Park	3.9	No developed park facilities	P, V	Two year rental agreement. Park development is a short term goal (2003 – 2012).
Issaquah Creek D	Cuff Property	0.89	No developed park facilities	P, V	Recently acquired by City.
Issaquah Creek E	Parcel 5097400055	0.32	No developed park facilities	P, V	City-owned; no new development currently planned.
Issaquah Creek E	Parcel 2343300045	0.26	No developed park facilities	P, V	City-owned; no new development currently planned.
Issaquah Creek F	Gibson Park	2.7	Play fields; playground; picnic shelter; meeting hall; restrooms	P, V	Developed; basketball court planned as long term goal (2003 – 2022).
Issaquah Creek F	Community Center Park	4.0	Not adjacent to creek, but partially within the SPA; contains pool, community center, offices, play fields	No access	Expansion of community center planned as long term goal (2003 – 2022).
Issaquah Creek G	Mine Hill Park;	5.0	Natural area; creek viewing platform; trail	P, V	City-owned; no new development planned.
Issaquah Creek G	Parcel 3324069498	0.28	No developed park facilities	P, V	City purchased for flood control. No new development currently planned.
Issaquah Creek G	Parcel 3324069500	0.32	No developed park facilities	P, V	City purchased for flood control. No new development currently planned.
Issaquah Creek G	Johnson Wythes Property	7.5	No developed park facilities	P, V	Recently acquired by city; undeveloped. Creekside riparian preservation/open space.

Table 1 Continued

Shoreline Reach	Park Name	Characteristics/Facilities		Type of Public Access[1]	Status[2]
		Size (Acres)	Characteristics		
Issaquah Creek H	South Issaquah Creek Greenway	10.3	Creek side and wetland open space area.	P, V	Creekside riparian preservation/open space.
Issaquah Creek H	Squak Valley Park North	11.0	Undeveloped open fields; picnic shelter; restrooms; trails viewing platform; parking	P, V	Design and development of parks is a short term goal (2003 – 2009). Master plan completed 2003.
Issaquah Creek H	Squak Valley Park South	12.5	Undeveloped open fields; picnic shelter; restrooms; trails viewing platform; parking	P, V	Design and development of parks is a short term goal (2003 – 2009). Master plan completed 2003. Squak Valley Park South is under construction (sports fields, restrooms, parking).
Issaquah Creek H	Foothills Open Space	46.8	Undeveloped open space	P, V	City-owned; no new development planned.
East Fork X & Issaquah Creek D	Building Facilities and Parks Maintenance Shop	4.0	Building Facilities and Parks Maintenance Shop and yard; not open to the public	No access	Identified to become part of the Issaquah Creek/Cybil Madeline park site.
East Fork Y	Former Murphy Property	0.23	No developed park facilities	P, V	Recently acquired by City.
East Fork Y	Corra Park	1.5	No developed park facilities	P, V	Life estate; residential use.
East Fork Y	Former Chevalier Property	0.51	No developed park facilities	P, V	Recently acquired by City.
East Fork Y	Former Davidson Property	0.38	No developed park facilities	P, V	Life estate; residential use.

[1] P = Physical Access; V = Visual Access

[2] Based on City of Issaquah Parks, Recreation, Trails and Open Space Plan Capital improvement Program (2003) and personal communications with City staff (Rosen, 2008).

The City's current inventory of public lands that provide access to the shoreline appears to be adequate to meet the existing demand, especially as recently acquired parks are developed or programmed to accommodate shoreline use. There may also be opportunities (via SMP policies, incentives and/or regulations) to provide additional public access to shorelines in conjunction with future commercial developments as long as the access does not conflict with the use or create a potential public safety or environmental risks.

References

City of Issaquah. 2003. Parks, Recreation, Trails and Open Space Plan. Updated 2004. City of Issaquah Parks and Recreation. Issaquah, Washington.

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Rosen, Peter. 2008. Personal communication with ESA Adolfson staff. Information on recent city open space acquisitions and private water-enjoyment uses, August 2008 and December 2008.